Implementation of *Every Learner Inquires* Initiative: Year One Evaluation Report

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Contents

Overview of *Every Learner Inquires* Initiative

Learning Point Associates is conducting the external evaluation of the implementation and impact of the *Every Learner Inquires* (ELI) initiative for the Iowa Department of Education. During the first year, the evaluation was designed to provide formative data that would have a bearing on the direction of the initiative in subsequent years. This report summarizes formative data about reactions to professional development, teacher learning, change in teaching practice, organizational support, and student learning. A subsequent report, to be delivered in September 2007, will examine changes in student achievement, comparing the first year to the baseline year.

ELI is a statewide science initiative sponsored by the Iowa Department of Education and extending from July 2006 through June 2010. This initiative seeks to foster an inquiry-based, student-centered approach to science instruction, as outlined in the *National Science Education Standards* (National Research Council, 1996). The goals of the initiative are to improve science learning for all students; build teacher leadership and content expertise in the area of science; provide teachers with the content and skills necessary to implement inquiry-based science instruction; and establish a structure for sustained implementation. In alignment with the Iowa Professional Development Model, this initiative provides teacher learning opportunities in two formats: professional development workshops that are held and sequenced over four years, and opportunities for collaborative professional learning at the building level.

The overall direction of the ELI initiative was based on a review of the research literature, conducted by a planning committee during the 2005–06 school year. A design team created the professional development model and planned specific workshops and follow-up activities that were delivered throughout the first year. The design team of 10 people was comprised of Department staff, science professional developers in five different Area Education Agencies (AEAs), professors at teacher preparation programs, staff developers from an Iowa school district, and four teachers at the elementary, middle, and high school levels. The instructional team was the subset of five members of the design team that facilitated the workshops. The participants, topics and learning goals, and professional development activities of this initiative are described later.

Participants

The ELI initiative is being implemented across the state of Iowa. Four case study schools are receiving intensive intervention with the purpose of providing formative data about their experiences of implementing and supporting the initiative. In addition, teams from area educational agencies participate in the initiative as part of a clustered support model. Additional details of these two forms of participation are described later.

Case study school teams were formed in four different schools, with one team coming from each school. Case study school teams are expected to include the entire science teaching staff and building principal as participants in the ELI initiative over a four-year period. As part of this commitment, all science teachers and the building principal are expected to participate in the professional development workshops and conduct follow-up planning meetings at their schools. In one elementary school, half of the teachers at each grade level attended each of the academic year workshops and provided “turnkey” training for the remaining teachers at that grade level. For the other case study teams, all science teaching staff (along with the principal) were expected to attend all workshops. Case study schools agreed to implement the instructional strategies presented in the professional development, keep logs of their implementation, allocate in-service time to supporting implementation, and cooperate with data collection for the evaluation. The level and type of participation of the case study schools was expected to remain the same throughout the four years of the initiative.

Eleven *AEA teams* were comprised of the AEA science education staff and from between two and seven teacher leaders drawn from schools within the given AEA. Some teams also included an administrator and science curriculum director from a school district within the AEA and a professor of science education from a local college. Each team ranged in size from seven to 18 individuals. These teams also participated in professional development, and the teachers on each team were expected to implement what they learned in their own schools. Unlike teachers in case study schools, however, AEA teams did not participate along with other teachers from their school or with their principal. Rather, their participation served to prepare them to provide professional development to schools in their respective areas upon completion of the second year of training. In other words, during the third and fourth years of the initiative, the AEA teams are expected to provide professional development for schools in their AEA region.

Topics and Learning Goals

The ELI initiative seeks to prepare teachers to implement inquiry-based instruction. Therefore, the professional development workshops have focused on building an understanding of scientific inquiry and inquiry-based instruction. To reinforce this understanding, the workshops themselves were designed to reflect the principles of inquiry as described later. Other workshop topics related to instructional techniques that supported inquiry and the organizational structures that would support implementation in schools. The following is a summary of these topics.

Inquiry

The goal of the ELI professional development program is to promote the implementation of inquiry-based learning in science classrooms at all school levels. Inquiry-based science education, or inquiry learning, is at the heart of the *National Science Education Standards* (NSES) published by the National Research Council (1996). The starting point for this approach is that the learning environment of a science classroom should reflect the essential features of the larger enterprise of science inquiry. Based on this starting point, the *NSES* describe five essential features of inquiry in teaching and learning:

- Learners are engaged by scientifically-oriented questions.
- Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically-oriented questions.
- Learners formulate explanations from evidence to address scientifically-oriented questions.
- Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.

- Learners communicate and justify their proposed explanations.

Each of these features can be implemented along a continuum that varies from teacher-directed to student-directed. The professional development described different variations of each feature along this continuum in order to help teachers understand the appropriate level of student-directedness to use in different situations. (A description of these essential features and their variations appears in Appendix A.) To support this learning, participants received three books from which they were assigned readings:

- *National Science Education Standards* (National Research Council, 1996)
- *Inquiry and the National Science Education Standards* (National Research Council, 2000)
- *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1994)

The Learning Cycle

The professional development addressed how to implement a pedagogical model with which to conduct inquiry learning. This model articulates five stages of inquiry, where each stage corresponds to a different learning goal. The model aligns with a student-centered, constructivist approach to science education. To this end, the model describes the teacher and student behaviors at each stage that will promote high levels of student involvement with generating and discussing questions, ideas, and explanations. The five stages in this model are as follows:

- **Engage.** Students become interested in a problem or a phenomenon and consider what they currently know about it.
- **Explore.** Students conduct investigations or develop common experiences so they can compare results and share ideas.
- **Explain.** Students explain concepts and ideas in their own words and use data from their investigations to support their explanations. Students learn to use appropriate scientific terms.
- **Elaborate.** Students apply what they learned to a new situation and draw conclusions based on evidence.
- **Evaluate.** Students compare their conclusions to those of others and perhaps revise their explanations. Students generate new questions that lead them into a deeper exploration of the topic.

How Students Learn

The professional development introduced research compiled from the National Research Council about how students learn. This research was referenced throughout the first year in reference to three critical learning needs: 1) Addressing preconceptions of learners, 2) building conceptual structures to organize factual information, and 3) fostering self-monitoring of learners. To facilitate learning these topics, participants were provided a copy of *How Students Learn* (National Research Council, 2005)

Accountable Talk. Accountable Talk is a collection of techniques for facilitating student interactions in the context of inquiry learning. These techniques are called "teacher moves." Different techniques are articulated for supporting the following facilitation purposes: supporting group discussion, supporting accountability to the learning community, supporting accountability to accurate knowledge, and supporting accountability to rigorous thinking.

Differentiation. The professional development included training on how to address the needs of all learners. Avenues for differentiation included allowing students to choose different assignments and providing background reading according to student reading level.

Professional Learning Communities. The workshops presented information about characteristics of collaborative groups in order to build the capacity of each of the teams to engage in collaborative learning activities.

Professional Development Activities

The professional development was delivered through a summer institute as well as five workshops throughout the academic year. In accordance with the Iowa professional development model, there were additional assignments and activities that provided ongoing practice between professional development workshops. These different activities are described in detail as follows.

Summer Institute and Workshops

Most of the interaction between participants and project staff (i.e., the design team) occurred during professional development workshops. There was a four-day summer institute in July 2006 followed by five one-day workshops that occurred throughout the school year in September, November, January, February, and April. The January and February workshops were delivered in both elementary and secondary strands, with teachers choosing the strand that corresponded to their grade level. To facilitate travel, each of the academic year training workshops was presented separately to participants in the eastern and western halves of the state.

During the workshops, teachers participated in several types of interactive learning activities designed to increase their level of involvement. During the summer institute, for example, participants experienced an inquiry-based science lesson from the perspective of a student. Following presentations from the instructors, participants typically would engage in a group or paired discussion. Participants engaged in written reflection several times per workshop. For example, they were asked to enter a "line of learning" in project journals, in which they described their current understanding of a particular topic. They also engaged in "quick writes" to answer a particular question.

Postworkshop Assignments

Following each workshop, teachers had an assignment to complete during the interval before the next workshop. The purpose of these assignments was to reinforce the learning that had occurred during the workshop. Examples of these assignments included interviewing students about their preconceptions, reading articles or book chapters, and conducting observations of other teachers to look for examples of the essential features of inquiry.

School-based Meetings

Each case study team met once per month at the building level to discuss assigned reading and to conduct group activities assigned by the project staff. For example, in January, teams discussed the aggregated results from a survey about change in teaching practice.

Web Board

Each case study and AEA team had its own discussion thread on an online, web-based discussion board. The main purpose of the web board was to facilitate communication among team members.

Evaluation

Learning Point Associates is conducting the external evaluation of the ELI initiative to provide formative and summative information to program stakeholders. During the first two years of the program, evaluations primarily will be formative, and will focus on program implementation. During the later years of the program, as participation scales up to include more schools, the focus of evaluation will shift to providing more summative information about program effects.

The evaluation uses a mixed-methods design to examine five levels of program outcomes:

- quality of professional development
- teacher learning
- organizational support
- level of implementation
- student learning

These outcomes are assessed using site-based data collection, implementation logs, surveys of teachers and students, and student achievement data. Because student achievement data were available too late for inclusion in this report, this evaluation report primarily addresses topics relating to the effectiveness of professional development, the level of teacher learning, organizational support, and implementation of inquiry learning.

This evaluation report provides both a broad and a focused view of the ELI initiative. The broad view includes the opinions of all participants who are participating in the ELI professional development and implementing their learning. This includes teacher leaders on AEA teams as well as the teachers at the case study schools. Participants' opinions regarding professional development and their level of learning, organizational support, and implementation are reported. The report covers an examination of the experiences of teachers at the case study schools, using site visit data and implementation logs to provide a rich understanding of organizational support for learning and implementation. It also includes the views of students at case study schools who completed science classroom surveys.

The evaluation is designed hierarchically, reflecting Guskey's (2000) five levels of evaluating professional development and its impact. Specific evaluation questions are included under each level:

Questions About Reactions to Professional Development

- What were teacher perceptions of the quality, utility, and relevance of the workshops?
- In what ways should the professional development be improved?

Questions About Teacher Learning

- What levels of self-efficacy do teachers have toward inquiry-based science instruction?
- To what extent do participants have a fundamental understanding about scientific inquiry?

Questions About Organizational Support

- To what extent does the administration advocate, facilitate, and support changes in teacher practice?
- To what extent are teachers participating in collaborative planning for inquiry?

Questions About Changes in Teacher Practice

- To what extent are teachers implementing inquiry learning?
- What are the factors that inhibit or facilitate implementation?

Questions About Student Learning

- To what extent have students acquired the abilities and fundamental understandings about scientific inquiry?
- What is the impact on student enthusiasm and self-efficacy toward science learning?
- Are the scientific understandings and abilities of students improving?
- Does the program address the needs of all subgroups?

Table 1 aligns each evaluation question with the data source that addressed it; these data sources are described in the Methods section. In brief, data sources included postworkshop reaction forms, teacher surveys, implementation logs, and interviews and classroom observations conducted during site visits. AEA teacher leaders participated in a subset of these data collection activities, based on their different participation requirements and goals. Because AEA teacher leaders participated in the professional development, they completed the postworkshop reaction forms and the teacher survey (which included items addressing professional development reactions and teacher learning). However, they did not participate in the implementation logs, interviews, or classroom observations because these instruments focused on organizational support and implementation of inquiry learning (two goals that their schools had not committed to). For the same reason, those items on the teacher survey that do address these latter goals are disaggregated by type of team affiliation (i.e., case study school vs. AEA).

Table 1. Crosswalk of Evaluation Questions to Data Sources

Evaluation Question	Teacher Survey	Teacher Interview	Principal Interview	Obser-vation	Teacher Logs	Student Survey	ITBS Data	Reaction Form
1. To what extent have students acquired the abilities and fundamental understandings about scientific inquiry?	x	x						
2. What is the impact on student enthusiasm and self-efficacy toward science learning?		x	x			x		
3. Does the program address the needs of all student subgroups?		x	x				x	
4. Are the scientific understandings and abilities of students improving?	x						x	
5. To what extent are teachers implementing inquiry learning?	x	x	x	x	x	x		
6. What are the factors that inhibit and facilitate implementation?	x	x	x					
7. To what extent does the administration advocate, facilitate, and support implementation	x	x	x					
8. Do teachers have opportunities to participate in collaborative planning for inquiry?	x	x	x					
9. To what extent do teachers have self-efficacy toward inquiry-based science instruction?	x	x						x
10. To what extent do participants have a fundamental understanding about scientific inquiry?	x	x	x					x
11. What were the perceptions of the quality, utility, and relevance of the workshops?		x	x					x
12. In what ways should the professional development be improved?		x	x					

Methods

The data collection and analysis involved qualitative and quantitative methods. The instruments used during the past year included postevent (i.e., professional development event) reaction forms, teacher and student surveys, teacher implementation logs, and site-based data collection using observation and interview methods. The overall timeline of data collection is described in Table 2. Due to the fact that the evaluation contract started in November 2006, data collection did not begin until January 2007.

Table 2. Schedule of Data Collection for 2007

2007	January	February	March	April	June
Postworkshop Feedback Forms	X	X		X	
Implementation Logs		X	X	X	
Classroom Observations				X	
Teacher/Principal Interviews			X		
Student Survey				X	
Teacher Practice Survey				X	
ITBS/ITED Data					X

Note: Case study teams participated in all data collection. Teacher Leaders from AEA teams participated in the Teacher Practice Survey and the Professional Development Survey.

Each of these instruments is described in a separate section that details its development, content, administration, and analysis.

Postworkshop Feedback Forms

The purpose of the postworkshop feedback form was to track participant satisfaction with the quality, utility, and relevance of the professional development workshops. The form asked participants to rate their level of agreement with six statements about the quality, utility, and relevance of the workshop. The form also presented four open-ended questions designed by project leaders to elicit feedback and reflections about specific learning topics. Because the latter questions do not closely align with the evaluation questions, they were not be analyzed. The workshops prior to January, which occurred before the start of the evaluation contract, did not use the same feedback form. For this reason, the postevent reaction forms for sessions prior to January were not analyzed.

Administration

Project leaders distributed a postevent reaction form to all workshop participants following each session. The form was completed with paper and pencil. Response rates from each session’s postevent reaction forms are not available because the overall attendance at each session had not been provided to the evaluator at the time of this report.

Analysis

Keeping with the focus of the evaluation, analysis of the postevent feedback forms included only those participants who would be responsible for implementing inquiry learning in schools. This excluded AEA staff who attended the sessions solely to learn how to train others in the inquiry-based approach. There were five separate sessions that were analyzed: elementary and secondary-level workshops in January and February and a combined workshop in April. The analysis of the reaction forms was descriptive. It involved examining the frequencies of responses to each item, and whether such frequencies changed over time. Thus, it was possible to see if certain ratings which were initially low tended to increase across sessions or whether the low ratings persisted.

Teacher Survey

The teacher survey was based on the *2000 National Survey of Science and Mathematics Education* developed by Horizon Research Incorporated (HRI). The HRI teacher survey was revised extensively based on discussions with the design team. The survey was modified considerably with the addition of several items that aligned more directly with the ELI initiative. The survey addressed all five levels of the evaluation:

- **Professional Development**. Five items asked teachers to rate the extent to which the ELI professional development prepared them to accomplish several broad instructional tasks.
- **Teacher Learning**. Teachers rated their self-efficacy in terms of implementing different aspects of the learning cycle; responses to these items comprised a Self-Efficacy Scale. A single item asked teachers to describe their level of understanding of the *NSES.*
- **Organizational Support.** The survey included items about organizational support that comprised three scales: Professional Learning, Principal Support, and Resources.
- **Impact on Teacher Practice**. Teachers were directed to rate the frequency with which students participated in different activities aligned with the essential features of inquiry learning; responses to these items comprised an Implementation Frequency Scale. Additional items asked teachers to rate the frequency of student-centered instructional techniques and differentiated instruction.
- **Impact on Student Learning.** Teachers rated the extent to which implementation of inquiry learning had improved student learning outcomes.

In sum, the survey included items intended to capture five constructs: self-efficacy, professional learning, principal support, resources, and implementation frequency. A psychometric analysis confirmed that the items could be combined to form valid and reliable measures of each construct. Additional detail about the content and validation of the survey is provided in Appendix B. The teacher survey itself is included in Appendix C.

Survey Administration

In mid-March 2007, Learning Point Associates e-mailed each participating teacher asking them to complete the survey via the Internet. At the request of Learning Point Associates, the director of the ELI initiative also sent a message to all participants asking them to respond to the survey. The survey remained open for three weeks. Evaluators sent two follow-up messages directly to nonrespondents, and also contacted the principals at case study schools to request that they remind all teachers to complete the ELI survey if they had not already done so. ELI project staff also sent a reminder message to nonrespondents encouraging their participation. Of the 83 teachers who were contacted, a total of 53 teachers completed the survey, for an overall response rate of 64 percent. See Table 3 for a breakdown of respondents by school type.

Table 3. Respondents by Case Study School

School	Num. Teachers	Surveys Completed	Rate
Case study schools	21	14	66.6%
Noncase study schools	62	39	62.9%
Total	**83**	**53**	63.8%

Student Survey

Learning Point Associates developed the student survey based on items from previously published instruments (see Appendix B for details). The survey items align with four constructs: science investigation, involved learning, enjoyment of science, and self-efficacy toward science. The first two constructs were used to evaluate the level of implementation of inquiry-based instruction. Participation in science investigations aligns with the inquiry-based instruction, and involved learning aligns with the instructional approach of the learning cycle. The latter two constructs were used to evaluate the impact on student learning. The items aligned with these scales are included in Appendix B. The student survey itself is included in Appendix D.

All items on the survey had a response scale of Yes, No, and Sometimes. The purpose of this simplified response scale was to accommodate the level of comprehension of younger survey participants.

Respondents

The student survey was administered during late April 2007 to students who were taking a science class in the case study schools in Grade 3 and above. The evaluator sent paper and pencil copy forms to each school, and each science teacher distributed the form to each student in his or her class. The number of respondents from each school ranged from 89 to 351. Although the total number of students enrolled in science courses was not obtained from the schools, only a single student declined to participate.

Validation and Analysis

Psychometric analysis indicated that three of the four item sets cohered as scales and were reliable and valid measures of the construct. The only one that did not cohere as a scale was self-efficacy for science. As a result, items addressing this construct were analyzed item by item, by examining response frequencies

The responses of elementary and high school students were analyzed to determine whether the two groups responded differently to the survey items. The responses of the two groups indicated that they perceived the different items differently. For this reason, the scale scores from these two groups are not comparable and must be reported separately.

Survey Analysis

The teacher and student surveys were analyzed using descriptive and inferential techniques. To describe overall trends, scale scores were interpreted by categorizing each participant according to his or her most likely response to an item of average difficulty (i.e., the difficulty of agreeing with the item). For example, for the construct of Principal Support, it was possible to estimate the likelihood that each participant would select the response options of *Not at all/Slightly, Somewhat, Moderately,* and *Very much so* for an item of average difficulty. Thus, the distribution of respondents among these categories provides a picture of overall perceptions of principal support. For the survey items that were not scaled, the analysis involves examining the frequencies of responses to each item.

To make inferences about relationships among constructs, scale scores from the teacher survey were correlated with each other. This approach was employed to examine the relationships between constructs of organizational support and implementation and between constructs of self-efficacy and implementation.

The analysis of the teacher survey took into account two important distinctions among teachers:

- For items addressing professional development and teacher learning, the responses were disaggregated by classroom type: self-contained or not self-contained. The former indicates that the teacher has a single group of students and that science is one of several topics taught during the day. The latter indicates that the teacher teaches science all day to different groups of students. This distinction is important because the latter group is expected to have a greater level of experience with inquiry instruction to begin with, owing to their status as full-time science teachers.
- For items addressing organizational support and implementation, teacher survey responses were disaggregated by participant type (case study versus AEA teacher leader). The case study teachers were expected to have stronger organizational support because the entire faculty of science teachers and the principal participated in the initiative (as described in the introduction to this report). The teacher colleagues and administrators of the teacher leaders, by contrast, were not expected to participate in the initiative, nor had the schools committed to supporting inquiry-based science instruction.

Based on these distinctions, t-tests were performed to examine group differences in responses to the relevant survey scales. For survey items that were not scaled, response frequencies were disaggregated by these groups, as relevant, to identify possible group distinctions.

Implementation Logs

In order to measure the prevalence of use of the five essential features of inquiry learning, teachers in case study schools were asked to complete Instructional Tracking Forms (ITFs). Teachers were instructed to fill out one ITF for each lesson they taught during a six-week period, where a lesson could extend over one or more class periods. The ITF was a grid of the five essential features and their different variations (i.e., levels of student centeredness). Teachers indicated the variation of each essential feature that was present in the lesson. Each feature is listed in Table 4, along with a label that will serve to facilitate discussion of the findings. The ITF is reprinted in Appendix E.

Table 4. Essential Features of Inquiry-Based Science Instruction

Essential Feature	Label
1. Learner engages in scientifically-oriented questions.	Question
2. Learner gives priority to evidence in responding to questions.	Evidence
3. Learner formulates explanations from evidence.	Explain
4. Learner connects explanations to scientific knowledge.	Evaluate
5. Learner communicates and justifies explanations.	Communicate

The ITFs initially were distributed at the February 2007 professional development sessions to all teachers from cohort schools. The facilitator of the session explained the instructions to the participants. The evaluator then mailed a follow-up letter to each teacher with a stack of ITFs with the same instructions. These forms were collected in mid-April at the professional development sessions or directly from teachers during April site visits. The evaluator did not request that teachers complete a minimum number of ITFs during this period.

Sixteen of 19 teachers submitted at least one ITF. The number received from each of these teachers ranged from one to 10, with a mode of six. Of the 16, 12 submitted at least four forms. Teachers submitted a total of 78 forms. The number of ITFs submitted by teachers of each classroom type is presented below in Table 5. Only two teachers from Harlan High School submitted more than one form. For this reason, the ITF data reflect only half of the teachers at this school.

Table 5. Number of Teachers Submitting ITFs and Number of ITFs Per Classroom Type

Classroom Type	Total Number of Teachers	Number of Teachers Returning ITFs	Number of ITFs
Self-contained	11	10	47
Not self-contained	8	6	31

Site Visits

During late April 2007, two evaluators from Learning Point Associates visited each case study school. During each site visit, evaluators conducted interviews with and observations of three teachers, along with an interview with the principal. In one school where there was only a single science teacher, observations were conducted for lessons delivered to three separate grades. Prior to the site visit, the evaluator arranged with the school which teachers would be interviewed and observed. Learning Point Associates consulted with each principal to select teachers in a range of grade levels. Each teacher was asked to teach an introductory lesson on a topic so that we were able to rate the same point in the learning cycle for all teachers. Teachers provided a lesson plan in advance of the visit so that evaluators would have the context to understand what the goals were and what activities would take place.

Observation Forms

Learning Point Associates developed observation forms designed to measure the level and fidelity of implementation. The forms were used to track which aspects of inquiry instruction were prevalent and which were not. Although the observation form addressed many aspects of a lesson, only those items that aligned with inquiry-based learning and the learning cycle were analyzed. These items appeared in the following two sections of the observation form:

- **Essential Features and Their Variations**. This was the same grid as the ITF. The evaluators indicated which variation of each essential feature was present in the lesson.
- **Ratings of Lesson Features**. This section of the form consisted of 23 features of lesson design, instruction, content, and climate that aligned with the learning cycle. The rater selected from three responses to indicate that a feature was "very descriptive" of the lesson, "somewhat descriptive," or "did not occur." The rating of "somewhat descriptive" indicated that some aspects of the feature were present but others were not, or that the feature received little emphasis. For example, the rating of "Teacher introduced terminology and alternative explanations after students express their ideas" was rated as *somewhat descriptive* where teachers provided a scientific term following a student discussion of ideas but the term had been introduced previously.

The observation forms were analyzed by calculating the proportion of lessons in which a particular item was observed. Appendix B describes the procedure for calculating the reliability of the observation instrument. The observation instrument itself is in Appendix G.

Interviews With Principals and Teachers

During site visits, Learning Point Associates conducted semistructured interviews with the observed teachers and the principal. The interview questions focused on all five levels of the evaluation: reactions to professional development, teacher learning, change in teacher practice, organizational support, and student learning. The teacher interview included questions about the lesson that was observed (e.g., the lesson's purpose). After the first site visit, five additional questions were added to the teacher interview protocol and were presented to the teachers at the remaining three schools.

The questions on the principal interview protocol were similar to those on the teacher protocol, although the latter included questions about teacher practice that were more detailed and probative than the ones on the former. Interview responses were content analyzed to identify the major themes reported by teachers and principals. Appendix F details the interview protocols.

Professional Development

In addressing the issue of professional development effectiveness, this section serves to answer two evaluation questions:

- **Question 1:** What were teacher perceptions of the quality, utility, and relevance of the workshops?
- **Question 2:** In what ways should the professional development be improved?

The data used to address these questions include Teacher Interviews, Professional Development Reaction Forms, and an online Teacher Survey.

As a part of the ELI program, teachers and principals alike were expected to participate in a series of professional development workshops. The initial meeting was a four-day summer institute followed by five one-day workshops in September, November, January, February and April. Attendance of case study teachers at these sessions was consistent with expectations. Teachers of nonself-contained classes attended most or all of the sessions, and teachers of self-contained classes attended about half of them. Three of the four principals attended most or all of the sessions, and one principal attended none.

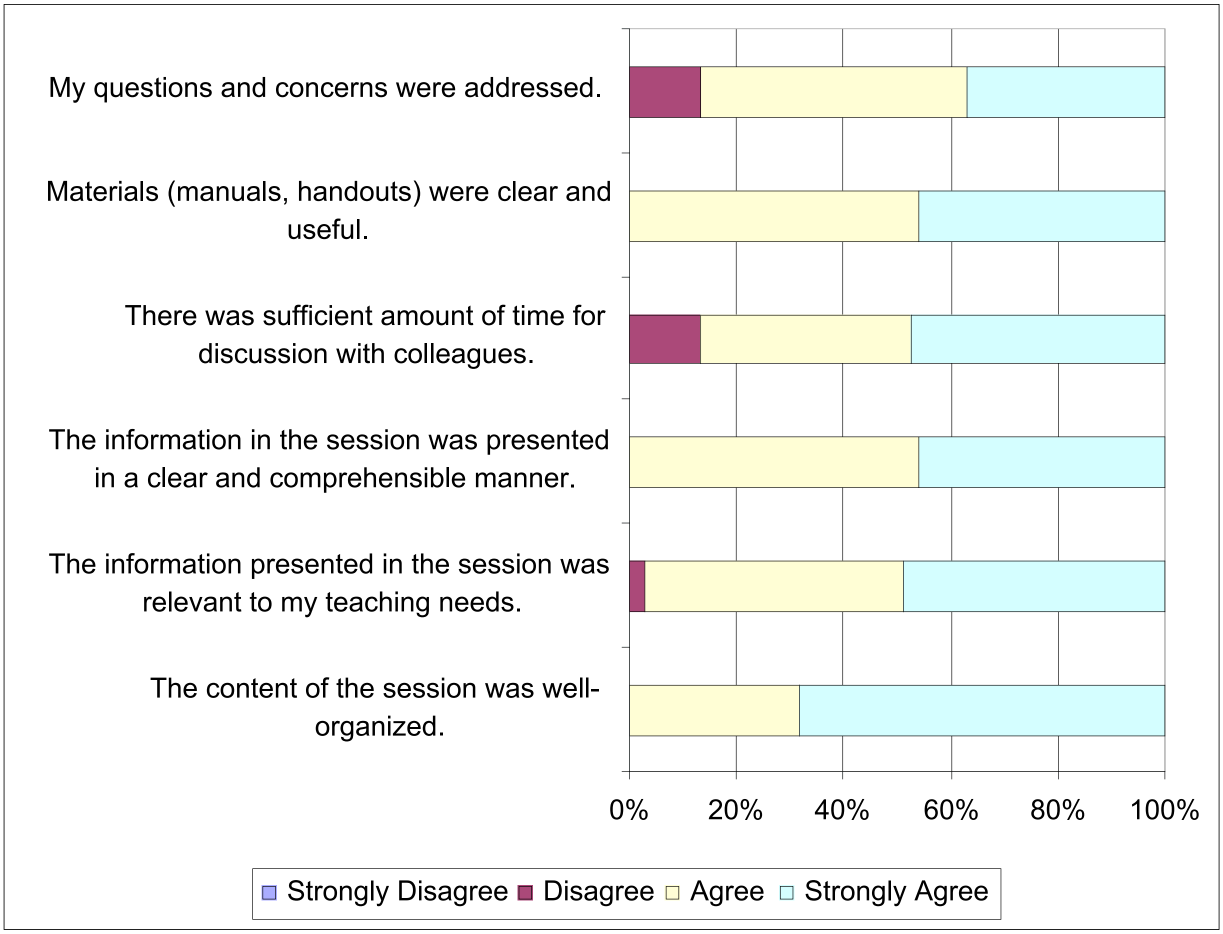
Satisfaction With Format and Content

Participants completed a reaction form following the workshops to record their perceptions and comments regarding the training. These forms were first administered following the January workshop, due to the fact that the evaluator's involvement with the project did not begin until just prior to the November workshop. Elementary and high school participants attended separate professional development workshops in both January and February. In April, the groups were combined and everyone attended the same session. Although teachers and principals completed this form, the responses of the latter were not analyzed due to their small number.

Figure 1 shows the responses of teachers as related to quality and relevance in the areas of content and collaboration. The figure illustrates that in January, all or nearly all of elementary teachers agreed or strongly agreed that materials were clear and useful, that the information was presented clearly, that information was relevant to their teaching needs, and that content was well-organized. Although most teachers at the elementary workshop agreed that their questions and concerns were addressed and that there was sufficient amount of time for discussion with colleagues, more than 10 percent did not agree.

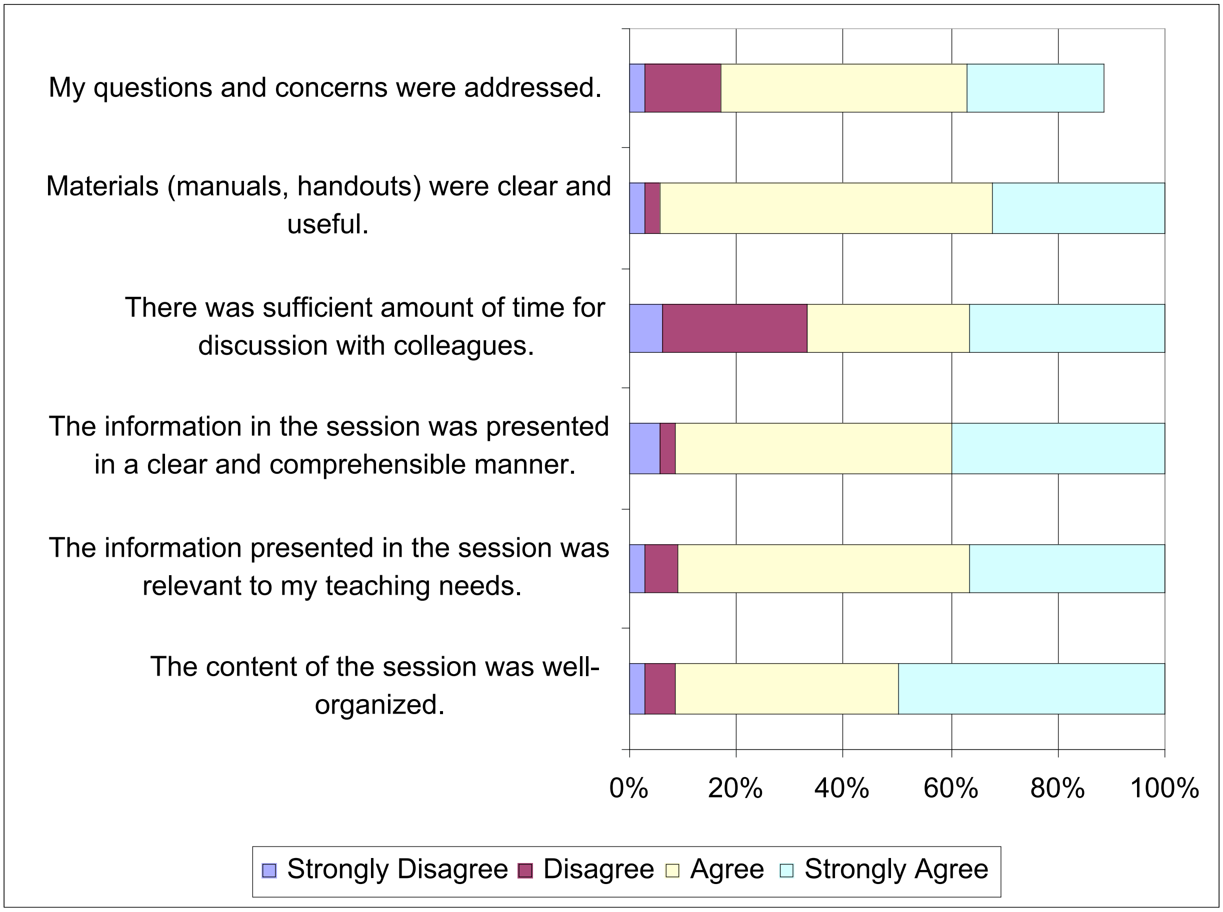
The overall pattern is similar for ratings of the secondary workshop in January, indicating that most teachers agreed with every item (see Figure 2Figure 2). There were two noticeable differences. Overall, the level of agreement was somewhat lower among secondary teachers, as indicated by the lower proportions of such teachers who strongly agreed. Second, more than a quarter of secondary teachers disagreed or strongly disagreed that there was sufficient time for discussion with colleagues, and 18 percent disagreed or strongly disagreed that their questions and concerns were addressed.

Figure 1. Ratings of January Workshop for Elementary Teachers



Note: $N = 39$

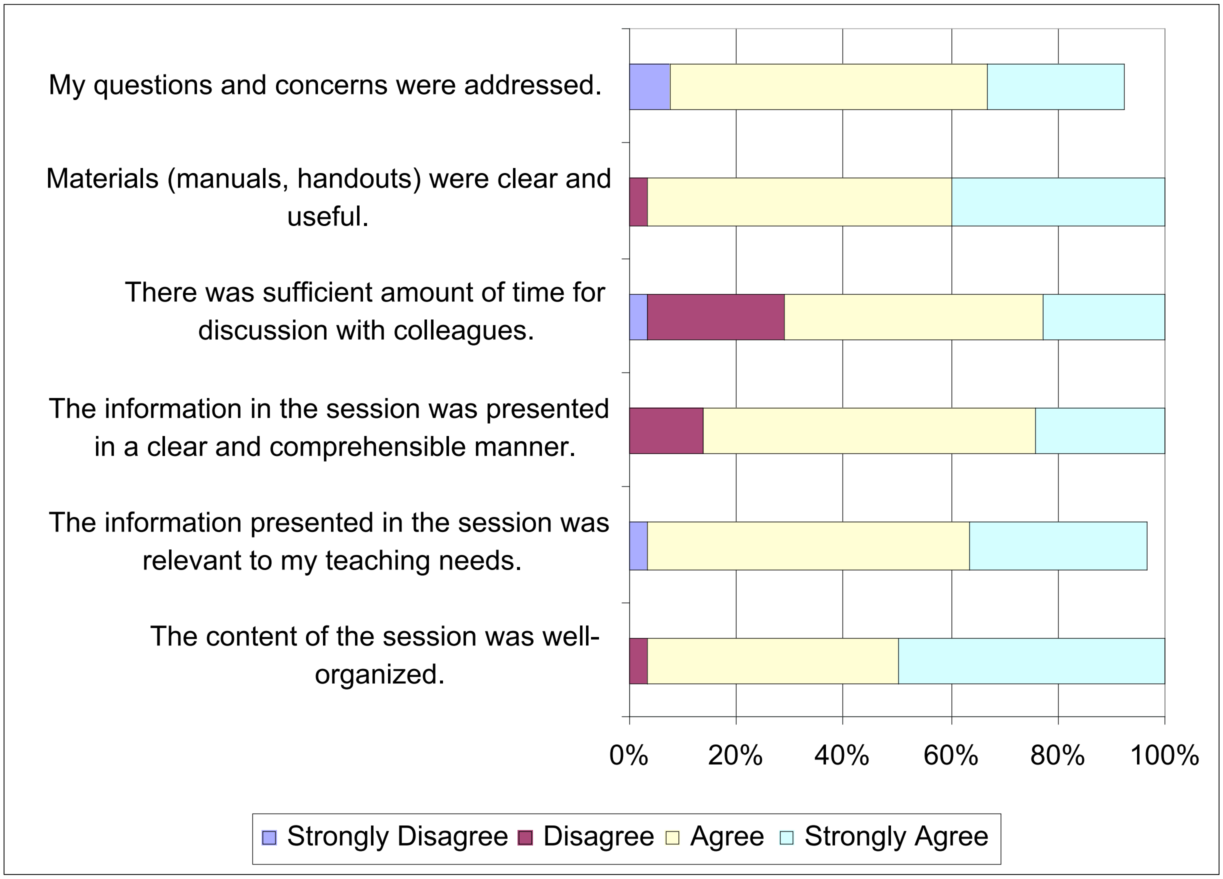
Figure 2. Ratings of January Workshop for Secondary Teachers



Note: N = 36. Some bars do not sum to 100 percent because of missing data.

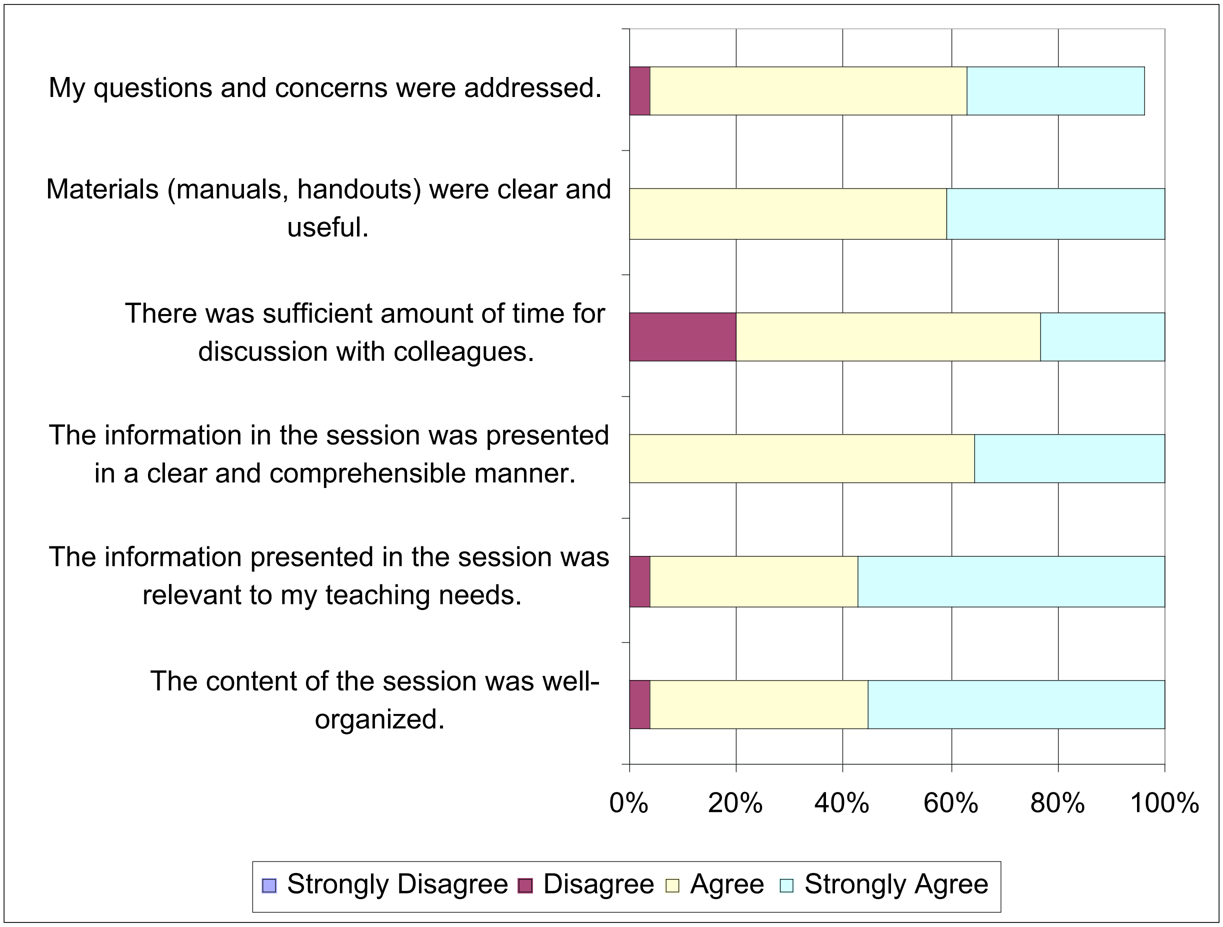
Results from the February workshops for elementary and secondary teachers reveal that most attendees continued to agree with all the items. Unlike the January workshops, however, the extent of agreement was greater among secondary than elementary teachers across most of the items. The one area of concern that was most prevalent for both workshops was time for discussion with colleagues. Roughly 30 percent of all elementary teachers either disagreed or strongly disagreed that there was sufficient amount of time for discussion with colleagues, as did 20 percent of secondary teachers. Additionally, 14 percent of elementary teachers disagreed that the information was presented in a clear manner. Figure 3 presents the summary of responses about the February workshop for elementary teachers; Figure 4 presents the summary for the secondary teachers.

Figure 3. Ratings of February Workshop for Elementary Teachers



Note: $N = 30$. Some bars do not sum to 100 percent because of missing data.

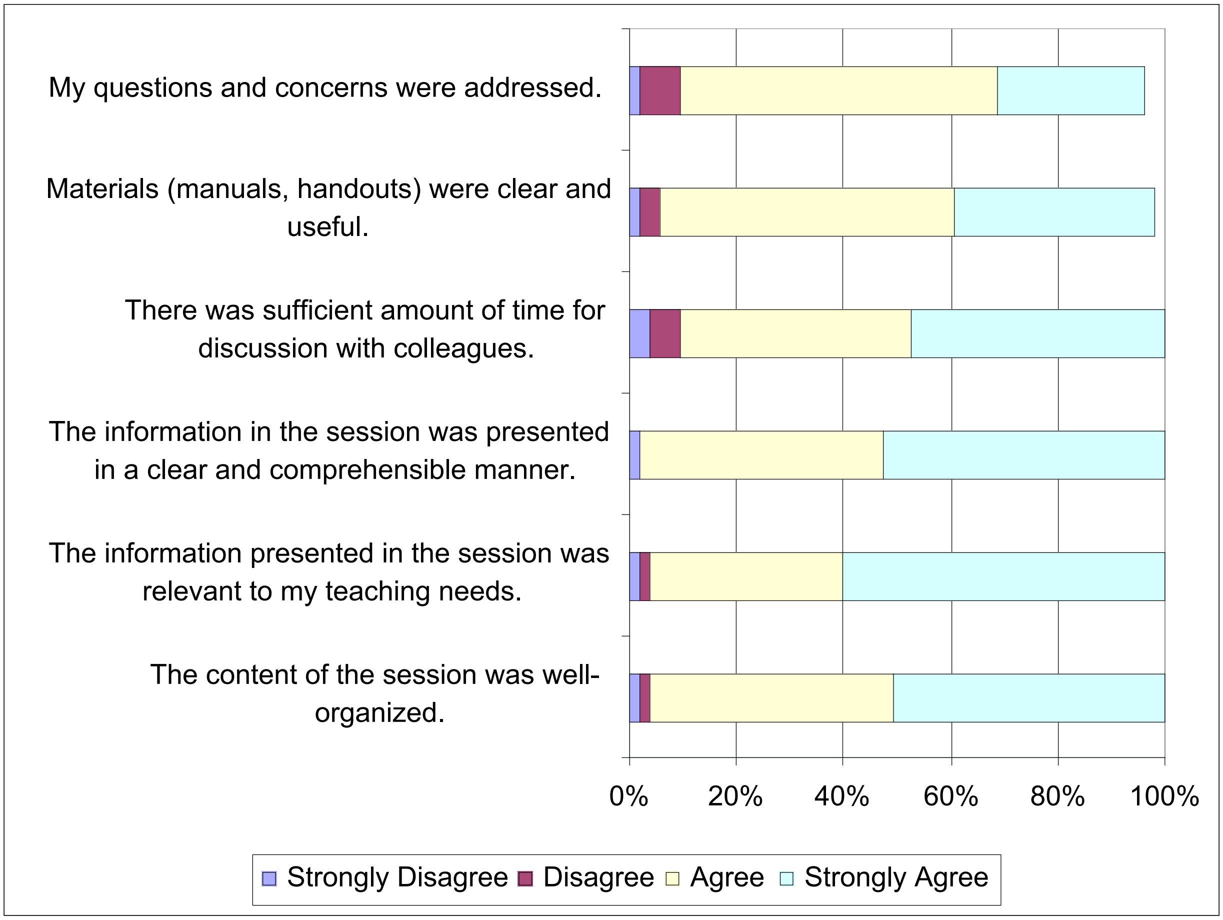
Figure 4. Ratings of February Workshop for Secondary Teachers



Note: *N* = 30. Some bars do not sum to 100 percent because of missing data.

During the April workshop, elementary and secondary teachers participated together. As displayed in Figure 5, at least 90 percent of all attendees agreed or strongly agreed across the six items. This suggests that the April workshop was organized in a manner that addressed the participants' concerns about sufficient time for discussions with colleagues.

Figure 5. Ratings of April Workshop



Note: *N* = 54. Some bars do not sum to 100 percent because of missing data.

During interviews in April, teachers and principals were asked to describe the strengths of the workshops. Nine of 10 teachers interviewed agreed that the professional development sessions were strong in several areas. Two of the teachers interviewed identified the interactivity of the sessions as a strength. Half the teachers described the opportunities to collaborate with colleagues as a strength and noted that these opportunities had increased in the most recent sessions. This is consistent with the overall increase in collegial discussion reported in April by all participating teachers in Figure 5. In this regard, one teacher stated, "teachers are having discussions that are real, not lip service, they express a desire to know more…it's genuine".

Three of the four participating principals interviewed cited collaboration with other science teachers and the knowledge of the presenters as strengths of the workshops. The fourth principal did not attend any professional development sessions.

Professional Development Effectiveness at Preparing for Implementation

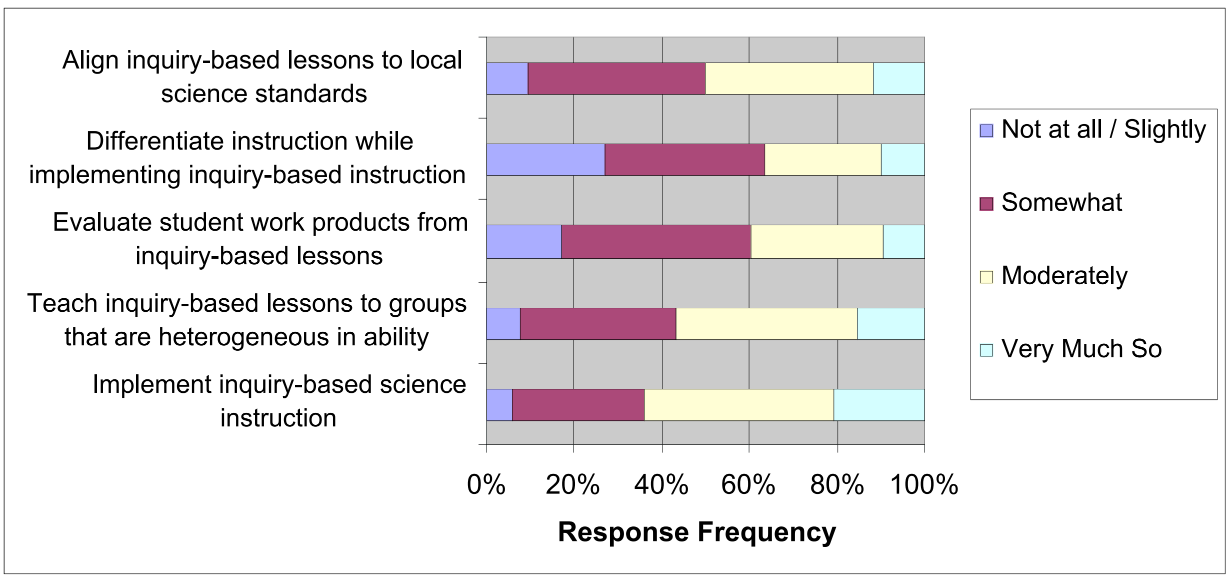
A group of items on the teacher survey asked teachers to rate the extent to which ELI participation has prepared them for different teaching tasks related to inquiry-based instruction.

As illustrated in Figure 6, at least 50 percent of classroom teachers rated their level of preparation by selecting “moderately” or “very much so” for the following items:

- Implement inquiry-based science instruction
- Teach inquiry-based lessons to groups that are heterogeneous in ability
- Align inquiry-based lessons to local science standards

Less than 40 percent of teachers selected “moderately” or “very much so” to describe the degree of preparations for evaluating student work products and differentiating instruction. However, teachers differed by classroom type in their ratings of differentiated instruction. Fifty-four percent of the self-contained classroom teachers are “moderately” to “very much” prepared as compared to 19 percent of the nonself-contained classroom teachers. Such a difference was expected since self-contained teachers have more time throughout the day to implement differentiation, unlike nonself-contained teachers who work with each class for only a short amount of time.

Figure 6. Preparedness for Instruction and Alignment of Inquiry Lessons



Note: *N*=54.

When considering these findings overall, at least one third of teachers indicated that the professional development workshops had prepared them only “somewhat” for each of the instructional tasks that was rated. These findings are examined further based on interview responses. In the teacher interview, seven teachers at three of the case study schools were asked, “How well did the *Every Learner Inquires* professional development prepare you to implement inquiry learning?” Four of seven teachers reported that the professional development was useful in preparing them for the implementation of inquiry learning. Two reported that they did not receive the amount of continual support they felt necessary to implement inquiry instruction. These teachers reported that they learned a lot during the workshop, but that they were unsure about how to implement inquiry instruction. In describing this lack of implementation support, one teacher stated, “I don’t feel that I have gotten as much support in taking that information, utilizing it in my classroom…what do I do with this information?”

Three of four principals indicated that the professional development helped their teachers implement inquiry instruction. However, one principal echoed teacher concerns about the preparation to implement inquiry instruction. He stated that the professional development was heavily focused on building knowledge, rather than building skill. He noted that the professional development did not provide specific implementation goals.

Taking the principal and teacher comments together with the survey results, a substantial minority of teachers expressed that they are not receiving concrete direction and support for implementing inquiry learning.

Suggested Changes to Professional Development

The Learning Point Associates interviewers posed the following question to all case study teachers: How could the professional development offered through ELI be improved? The prevailing response for a way to improve the professional development session was an increase in time for discussion with colleagues. Half the teachers interviewed expressed a need for more time in the workshops for collaboration, discussing implementation strategies, and planning. For example, one participating teacher stated, “If time were allotted, everybody could bring one portion of one unit… and spend group time getting ideas from other people.”

There were other suggestions made about ways to improve the professional development workshops. One such suggestion was to gear more information in the sessions to those who teach on the elementary level. This particular teacher articulated that many of the ideas and strategies were not designed for elementary school students and thus were difficult to implement. Still another teacher suggested that more information be disseminated about assessments. The teacher went on to state, “I would like to see more on assessments because even in fourth grade we have to assess students…you need to be able to assess them”.

The methods of improving the professional development sessions suggested by the principals were mostly administrative. One suggested that a teacher from his school be added to the planning team. Another two made comments referring to improving communication between project staff and the schools. Specifically, one principal requested more direct conversations rather than e-mail messages, and another principal sought more information about the schedule for what changes in educator practice are expected to occur when. This latter suggestion echoes the finding noted earlier about a perceived lack of clarity about what should be implemented.

Summary

Most teachers were satisfied with the qualitative aspects of the professional development sessions, such as organization, materials, and presentation. The most consistent recommendation for improvement of the professional development workshops is to increase opportunities for team-based planning and collaboration.

A majority of teachers indicated that the professional development had prepared them to implement inquiry-based learning, align to local standards, and teach to heterogeneous groups. Nevertheless, a substantial minority did not state that the professional development had prepared them for these tasks. Only a minority said that the professional development had prepared them to assess student work and differentiate instruction.

Some principals also requested clearer communication from project leaders, such as about the direction of professional development and implementation goals.

Teacher Learning

In addressing the topic of Teacher Learning, this section serves to answer two evaluation questions:

- **Question 3:** To what extent do teachers have the self-efficacy needed to implement inquiry learning?
- **Question 4:** To what extent do teachers have a fundamental understanding about scientific inquiry?

The data used to address these questions come from the online Teacher Survey and Teacher Interviews.

Teacher Self-Efficacy and Understanding of Inquiry Learning

The teacher survey included several items concerning the self-efficacy toward the instructional tasks related to the learning cycle. These items were combined in a single scale score. A *t* test was conducted and revealed that teachers did not differ significantly in their self-efficacy toward implementing the learning cycle based on their classroom type (i.e., self-contained vs. not self-contained), $t(50) = .87$, *ns*. Therefore, the level of self-efficacy is described in the aggregate.

Using the teacher self-efficacy scale scores and the Rasch rating scale thresholds (the scaled transition points between adjacent categories), teachers were classified according to their most likely response to an additional item of "average" difficulty. Such classification serves to translate the scale score metric into the terminology of the survey (i.e., the response options of "very prepared," "moderately prepared," "somewhat prepared," and "not at all/slightly prepared").

Table 6 shows the expected distribution of the teachers across the rating categories. Less than one fifth of teachers were likely to report being very prepared to implement the learning cycle, but more than two thirds were likely to report being at least moderately prepared. No teacher reported being not at all or slightly prepared.

Table 6. Teacher Self -Efficacy Rating

Rating	*N*	Percent
Very prepared	9	17.3%
Moderately prepared	27	51.9%
Somewhat prepared	16	30.8%
Not at all/Slightly prepared	0	0.0%
Total	**52**	**100.0%**

Note: Two survey respondents did not complete enough items to calculate a scale score.

The results from the interviews mirror the survey results. Case study teachers also were asked about their understanding of the learning cycle. All respondents stated that they had at least a general understanding of the learning cycle. Five indicated that they understand the learning cycle very well. One respondent explained, “I know the learning cycle fairly well. We’ve been doing hands-on science even before the ELI program.”

As described in the introduction, the *National Science Education Standards (NSES)* is the essence of inquiry learning. Thus, comprehension of the NSES is directly connected to understanding the five essential features of inquiry learning. Most teachers participating in the ELI program reported being fairly or very familiar with the NSES. However, there is a notable amount of variance among classroom types. As displayed in Table 7, 80 percent of the teachers from nonself-contained classrooms are either fairly familiar or very familiar with the *NSES*; 44 percent of the self-contained classroom teachers fall within the same range. More than half reported being somewhat or not at all familiar with the *NSES*, and in essence, not being familiar with the five essential features. Because teachers of nonself-contained classrooms are full-time science teachers, it is understandable that they would be more familiar with standards for science education. The level of understanding of the *NSES* will be tracked over the course of the initiative.

Table 7. Teacher Level of Familiarity With *NSES*

Self-Contained Classes (*n*=27)	**Not at All Familiar**	**Somewhat Familiar**	**Fairly Familiar**	**Very Familiar**
How familiar are you with the *National Science Education Standards* published by the National Research Council?	3.7%	51.9%	33.3%	11.1%
Nonself-Contained Classes (*n*=26)				
How familiar are you with the *National Science Education Standards* published by the National Research Council?	0.0%	19.2%	42.3%	38.5%
Total (*N*=53)	**1.9%**	**35.8%**	**37.7%**	**24.5%**

During the teacher interview, teachers were asked to describe their level of understanding of the essential features of inquiry-based science instruction. Seven teachers indicated that they had at least a working knowledge of the essential features. Of these, three stated that they had implemented inquiry instruction for several years and consider themselves very well versed in the five essential features of inquiry. As one respondent stated, “I know most of the five features pretty well. I’ve done them through the years.” Three teachers indicated that while they have a working knowledge of the essential features, they are not completely comfortable utilizing each of them in the classroom.

In summary, most teachers have a working knowledge of inquiry-based instruction. Although teachers of nonself-contained classes understood the *NSES* better than teachers of self-contained classrooms, they did not differ greatly in their self-efficacy toward implementing the learning cycle. All teachers professed a general understanding of the learning cycle and most teachers rated a moderate level of self-efficacy for implementing it.

Impact on Teaching Practice

The evaluation examined the following questions about changes in teaching practice:

- **Question 5:** To what extent are teachers implementing inquiry learning?
- **Question 6:** What are the factors that inhibit and facilitate implementation?

This section presents data regarding classroom implementation of inquiry learning. These data are formatively useful for identifying the aspects of the initiative that are fully or less than fully implemented. Data sources include teacher and student surveys, implementation logs, classroom observations, and interviews with principals and teachers. Findings about classroom implementation of the initiative are discussed in sections corresponding to the essential features of inquiry, the learning cycle, and differentiated instruction. A final section presents findings about barriers to implementation of inquiry-based learning.

As discussed in the introduction, there are two major distinctions between teachers that could be expected to influence the level of implementation of inquiry learning. One is the distinction between teachers of self-contained and nonself-contained classrooms. Because the former teaches science only part of the time, it may take them longer to learn how to put their learning about inquiry into practice. On the other hand, they may be less constrained by established practice than those who teach science full-time (i.e., teachers of nonself-contained classrooms) and therefore more willing to change.

The other distinction is between teachers from case study schools and those who participate with AEA teams (i.e., teacher leaders). The case study schools participate under the requirement of committing to the implementation of inquiry-base science instruction. Teachers from these schools are expected to receive greater organization support and therefore to implement the ELI initiative to a greater degree. Both of these distinctions among teachers will be examined throughout this section.

Essential Features of Inquiry

Level of implementation of inquiry-based instruction was evaluated in terms of the level of use of the five essential features of inquiry instruction, along with their variations. In discussing the essential features, it is useful to refer to them in an abbreviated manner. For this reason, each feature is listed in Table 8 with its label. As noted in the introduction, these essential features can be implemented along a continuum that varies from highly teacher-directed to highly student-directed. The ELI initiative envisions all teachers being able to implement each feature along the full continuum. Appendix A presents a matrix that describes how each feature varies along this continuum.

Table 8. Essential Features of Inquiry-Based Science Instruction

Essential Feature	Label
1. Learners are engaged by scientifically oriented questions.	Question
2. Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.	Evidence
3. Learners formulate explanations from evidence to address scientifically oriented questions.	Explain
4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.	Evaluate
5. Learners communicate and justify their proposed explanations.	Communicate

Overall, it appears that teachers are implementing these essential features to a moderate extent. However, some features are implemented more frequently than others, and they tend to be implemented in primarily a teacher-centered manner. Some findings describe the general level of implementation (i.e., across all features), and other findings describe the prevalence each specific feature and its variations. For example, the Implementation Frequency scale on the teacher survey and the Investigations scale on the student survey provide an overall perspective on the implementation of the inquiry approach. Findings from the implementation logs and observation forms addressed the prevalence of specific features and their variations. Finally, interview comments address implementation in both an overall and specific manner.

Overall Implementation of the Essential Features of Inquiry

When aggregating across all of the essential features, it appears that all teachers state they are implementing them at least monthly, and that about half are doing so with greater frequency. The first source of data for this finding is the Implementation Frequency scale, comprised of eight items from the survey. These items asked teachers to report on the frequency with which students engaged in certain behaviors indicative of the five essential features of inquiry learning. For each teacher, it was possible to calculate a scale score to indicate his or her frequency of implementation. Using this scale score and the Rasch rating scale thresholds (the scaled transition points between adjacent categories), each teacher was classified according to his or her most likely response to an additional item of "average" difficulty. Such classification serves to translate the scale score metric into the terminology of the survey. Table 9 shows the expected distribution of the teachers across the various rating categories of "almost never," "a few times a year," "once or twice a month," "once or twice a week," or "all or almost all lessons."

Table 9. Most Likely Responses to Items of Average Difficulty on the Implementation Frequency Scale

Implementation Frequency Scale Score	Count	Percent
All or almost all lessons	2	3.8%
Once or twice a week	25	48.1%
Once or twice a month	23	44.2%
A few times a year	1	1.9%
Almost never	1	1.9%
Total	**52**	**100.0%**

Note: Two survey respondents did not complete enough items to calculate a scale score.

Based on this categorization, it appears that about half of all teachers were likely to report implementing the essential features at least weekly, and nearly as many were likely to report implementing them monthly. An independent samples *t* test indicated that teachers did not differ in their level of implementation based on classroom type (self-contained or not self-contained), $t(50) = 1.26$, *ns*. Nor did teachers differ on the basis of participation type (case study versus AEA), $t(50) = 1.01$, *ns.* As a result, findings from this scale are not disaggregated by these distinctions.

A similar pattern is evident in responses to a survey item that asked teachers to describe the extent of implementation of inquiry learning. As shown in Table 10, about half of the teachers selected "moderately (most or all features with some variations)," and another 10 percent stated "very much so (all features with most or all of their variations)." More than one third stated that they implemented these features to a lesser extent. Once again, there appears to be variation among teachers in their extent of implementation.

Table 10. Perceived Level of Implementation of Inquiry Learning (Teacher Survey)

To What Extent, If at All, Are You Currently Implementing Inquiry Learning? (Consider the Level of Implementation of the Different Features Along With Variations in Amount of Student Self-Direction.)	Total ($N = 52$)
A little bit (one or two features with little or no variations)	6%
Somewhat (some features with some variations)	31%
Moderately (most or all features with some variations)	54%
Very much so (all features with most or all of their variations)	10%

Note: Two survey respondents did not complete enough items to calculate a scale score.

Teacher and principal interview responses also indicate broad implementation as well as variations in extent of implementation. During interviews, teachers and principals were asked to describe the extent to which they had been implementing inquiry-based instruction during the preceding three months. All teachers stated that they were implementing inquiry based instruction at least some of the time. All four principals reported that inquiry was being implemented extensively in their schools. However, it appears that teachers may be divided into two groups:

- One group, consisting of five teachers, stated that they had used inquiry extensively throughout the previous three months. Four of these teachers explained that they already had been using Inquiry prior to the implementation of ELI.
- A different group consisting of four teachers said they implemented inquiry-based instruction somewhat during the preceding three months. In most cases, they were not able to complete a full cycle. One teacher mentioned that he or she was attempting to move from teacher-led to more student-led inquiry.

In summary, teacher and principal interviews and the teacher survey indicate that there is broad implementation, but that the level of implementation differs among teachers.

Students also report that their science instruction is reflective of inquiry learning, at least some of the time. This is indicated by responses to the Investigations scale on the student survey, which is comprised of eight statements about students collecting and analyzing data to answer scientific questions. Student survey findings are presented separately for elementary and high school students because the survey validation indicated that these two groups responded differently to the survey items.

Using the student Investigations scale scores and the Rasch rating scale thresholds (the scaled transition points between adjacent categories), each student was classified according to his or her most likely response to an additional item of “average” difficulty. Such classification serves to translate the scale score metric into the terminology of the survey. Table 11 shows the expected distribution of the students across the various rating categories. More than 95 percent of elementary students typically responded “yes” or “sometimes” to items of average difficulty, and about 85 percent of high school students typically responded “yes” or “sometimes” to items about science investigations.

Table 11. Typical Responses of Elementary and High School Students to Items on the Investigations Scale

Investigations Scale Score	Elementary (n = 539)	High School (n = 350)
Yes	50.5%	33.4%
Sometimes	45.6%	51.1%
No	3.9%	15.4%

Student ratings of Investigations also indicate variations among teachers in the degree to which science lessons reflect investigative learning. That is, rating on the Investigation scale varied systematically by teacher, as indicated by a one-way analysis of covariance (ANCOVA) that controlled for student ratings of Involvement and Liking of Science. This finding held for elementary students (F [9, 525] = 9.00, $p < .001$) and high school students (F [4, 341] = 15.78, $p < .001$). For this reason, it was appropriate to categorize teachers according to the typical student rating for Investigations based on their mean student ratings. Table 12 describes the number of teachers per school level who were categorized according to the different student response categories.

Table 12. Mean Rating of Teachers by Students for the Investigation Scale

Mean Student Response on Investigations Scale	Elementary (n = 539)	High School (n = 350)
Yes	6	1
Sometimes	5	3
No	0	0
Total	**11**	**4**

This pattern of results seems to correspond with the teacher responses to interviews and surveys, which indicated that some teachers are implementing inquiry learning to a greater extent than others. However, the picture becomes somewhat less clear when each teacher is classified in a "confusion matrix" that indicates the teacher's self-rating (i.e., from the teacher survey) and the teacher's classification based on the mean Investigation scale score from the student survey. Table 13 displays these results. There does not appear to be a trend for teachers who have high scores on Implementation frequency to have a greater mean student rating of Investigation. There are not enough teachers with both sources of data to conclude confidently that these scales are unrelated. Nor can it be said that the student survey corroborates the teacher survey findings. However, it may be said that the student survey indicates that classrooms differ in the extent to which students participate in investigations.

Table 13. Crosswalk of Teacher Self-Ratings and Mean Student Ratings for Implementation Frequency and Investigation Scales

	Teacher Self Rating		
Mean Student Rating	**Daily**	**Weekly**	**Monthly**
Yes	0	1	2
Sometimes	1	2	3

One possible source of the discrepancy between the student and teacher surveys could be that the student survey items each describe a rather student-centered aspect of the classroom. Perhaps some teachers frequently implement the essential features in a manner that is teacher- rather than student-centered. To investigate this possibility, the next section examines which of the essential features are more fully or less fully implemented, and the manner in which they are implemented.

Prevalence of Essential Features and Their Variations

Several sources of data are used to indicate the prevalence of the essential features and their variations in student-centeredness. These include the items comprising the Implementation Frequency scale (examined individually), implementation logs, observations, and interviews. Overall, these data indicate that some of the essential features are prevalent, but that they tend to be implemented in a teacher-centered manner.

Teachers used implementation logs to describe which of the essential features of inquiry were implemented in each of their lessons over a six week period. Table 14 displays the proportions of lessons in which each essential feature was reported as being present. The table presents the findings separately by classroom type, due to some differences between these two groups.

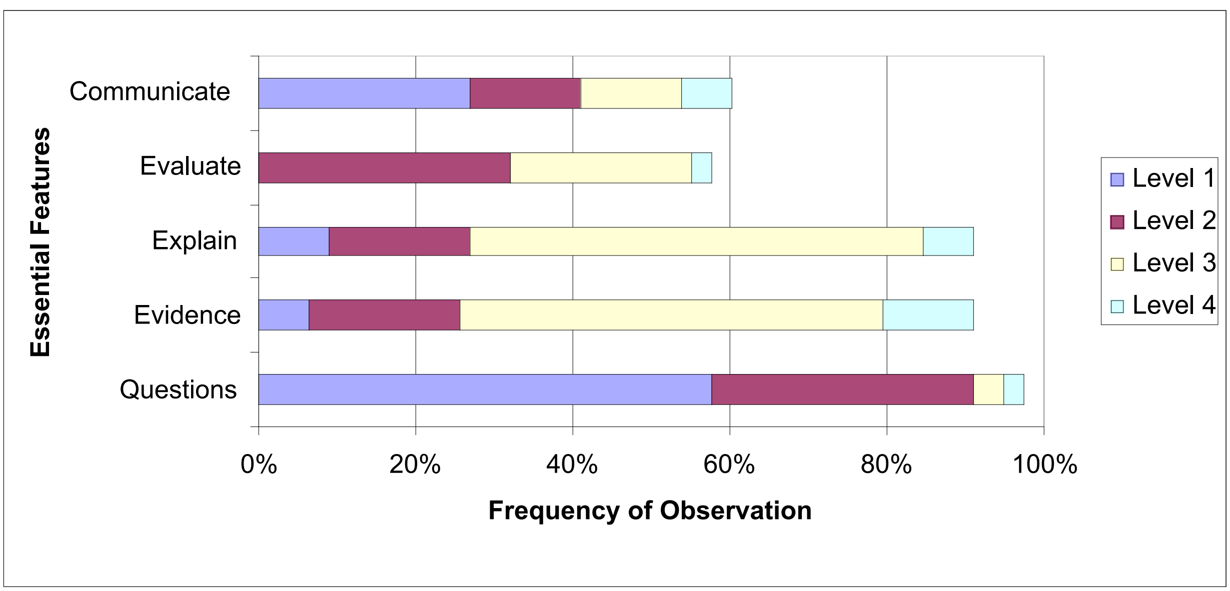
Table 14. Percentage of Lessons Reflecting Each Essential Feature (Implementation Logs)

Classroom Type	*N*	Question	Evidence	Explain	Evaluate	Communicate
Not self-contained	31	96.3%	96.3%	96.3%	92.6%	92.6%
Self-contained	47	98.0%	88.2%	88.2%	39.2%	43.1%
Total	**78**	**97.4%**	**91.0%**	**91.0%**	**57.7%**	**60.3%**

- Teachers from nonself-contained classrooms indicated that all features were present in most lessons.
- Teachers from self-contained classrooms indicated that most science lessons included the essential features of engaging with scientific questions (98 percent of all lessons), giving priority to evidence (88 percent of lessons), and formulating explanations from evidence (88 percent). However, only about 40 percent of their lessons included the features of connecting explanations to scientific knowledge or communicating results.

The implementation logs were analyzed to examine the prevalence of different variations of each essential feature. As mentioned previously, the variations are presented in levels of student-directedness, where Level 1 indicates a low degree of student-centeredness, and Level 4 indicates high levels of student-centeredness (see Appendix A for a description of each variation for each feature). These findings are presented in Figure 7 and explained later. The prevalence of each variation for a particular feature was the number of lessons that incorporated that variation divided by the total number of lessons which incorporated any variation of that feature.

Figure 7. Percentage of Lessons Reflecting Different Variations of Essential Features



Note: Based on 78 ITFs. Higher levels indicate greater degrees of student-centeredness, as described in Appendix A.

- The most prevalent variation of Question (three fifths of such lessons) was Level 1, the least student-directed level. With this variation, students engaged in a question provided by the teacher, materials, or other source.
- The most prevalent variation of Evidence, exhibited in more than half the lessons, was where the teacher directs the learner to collect certain types of evidence (Level 3). This is more prevalent than Levels 2 and 1, where the learner analyzes data without collecting it. However, lessons seldom required that students themselves identify what evidence to collect (Level 4).
- The most prevalent variation of Explain, exhibited in more than half the lessons, was where the learner is given possible ways to use evidence to formulate explanation (Level 3).
- Only about 60 percent of lessons were aligned with the Evaluate feature. Among those that were, the most frequently endorsed item was where teachers suggest possible connections to scientific knowledge. This was the most teacher-directed response available.
- Only about 60 percent of lessons were aligned with the Communicate feature. Among those that were, the most frequently endorsed item was where teachers provide steps and procedures for communication (Level 1).

In summary, the implementation logs demonstrate that teachers tend to use the essential features early in the process, and that use of these features tends to be rather teacher-directed.

Classroom observations provided an objective look at the practices in the classroom. During classroom observations, observers noted which essential features and their variations occurred during each lesson. These findings are reported in Table 15. Lessons in eight of 11 classrooms exhibited the first essential feature (Question), and an additional five exhibited the second essential feature (Evidence). The Explain and Evaluate features were observed in two classrooms each, and the Communicate feature was observed in a single classroom. In summary, the observation data are consistent with the findings from the implementation logs and surveys, and indicate that the earlier stages of inquiry learning are more prevalent. However, in the case of the observation data, this finding may reflect the fact that teachers were asked to teach an introductory lesson during the observation.

Table 15. Observed Frequency of Essential Features of Inquiry

Essential Feature	Count	Percent
Question	8	73%
Evidence	5	45%
Explain	2	18%
Evaluate	2	18%
Communicate	1	9%

The essential features in the classroom observations also tended to be implemented in a teacher-directed, rather than student-directed, manner:

- In six of the eight classrooms where the Question feature was observed, the learner engaged in a question provided by the teacher (i.e., Level 1). In two of these classrooms, the learners posed a question (Level 4).
- In four of the five classrooms where the Evidence feature was observed, the learner collected the evidence. In two of these four classrooms, the learner determined what constituted evidence and collected it (Level 4), and in the other two, the learner collected certain types of evidence under direction from the teacher (Level 3). In the remaining classroom where the Evidence feature was observed, the students were given data and told to analyze it (Level 2). A complete chart describing the frequency of different variations of the essential features in provided in Appendix H.

Finally, the predominance of the Question feature was also noted during interviews. When asked to describe their implementation, three teachers reported a focus on the Question feature, and no teacher mentioned any other feature.

Summary of Findings on Implementation of Inquiry-Based Instruction

Most teachers reported that they implement inquiry learning either once or twice a week or once or twice a month. Most students reported that their science lessons reflect investigative learning, at least sometimes. A greater proportion of elementary students than high school students reported taking part in science investigations.

Data from the implementation logs, observations, and interviews suggest that the essential features related to scientific questions and the use of evidence are most prevalent and that they most typically are implemented in a teacher- rather than student-directed manner. Implementation of two essential features (Evaluate and Communicate) was frequently reported by teachers of nonself-contained classrooms, but not by teachers of self-contained classrooms. In interviews, most teachers stated that they have not yet taken students through an entire inquiry cycle. These findings seem somewhat at odds to teacher responses to the single survey item about level of implementation, where more than three fifths of teachers stated that they were using most or all of the essential features and their variations. It is possible that this particular item was too vague to reflect differences among features (see Table 10), seeing that it did not ask about each feature specifically.

Implementation of the Learning Cycle

The 5E Learning Cycle (henceforth referred to as “the learning cycle”) is the pedagogical framework which supports inquiry learning. The phases of the cycle articulate the steps by which students become engaged with and explore scientific phenomena; explain findings; extend them to new situations; and compare their conclusions with other investigators. Three items from the classroom observations assess the degree to which lessons accomplished the specific instructional goals that are consistent with the initial phases of the learning cycle (i.e., engage with and explore a phenomenon). Most of the findings address the extent to which lessons adhered to the student-centered, constructivist approach to science education that underlies every phase of the learning cycle.

Lesson Introduction

The observed class periods were supposed to present the introductory phases of the lesson (i.e., engage with and explore a phenomenon). For this reason, the observation instrument included three items that aligned with the goals of these introductory phases, as described in Table 16. Most lessons included activities designed to generate student interest (item 1); a majority of these lessons were rated as “very descriptive” in this regard. In eight of 11 lessons, student exploration preceded formal presentation (item 2). In only three lessons did teachers introduce scientific terminology after students had expressed their ideas. The low rating for this item is understandable because many of the lessons had not yet reached the point where teachers would introduce terminology. Therefore, it appears that lessons commonly addressed the major goals of the engaging student interest and exploring phenomena.

Table 16. Frequency of Ratings of Learning Cycle Items

Learning Cycle Items	Did Not Occur	Somewhat Descriptive	Very Descriptive
1. The lesson included activities designed to pique students' curiosity and generate interest.	1	3	7
2. In this lesson, student exploration preceded formal presentation	3	3	5
3. Teacher introduced terminology and alternative explanations after students express their ideas.	8	3	0

The lesson observations cannot address the implementation of the full learning cycle because only a single class period could be observed. During interviews, however, teachers were asked to describe their overall level of implementation of the learning cycle. Teacher comments indicated at least two levels of use. One group comprised of six teachers reported using the learning cycle at least 50% of the time during the preceding three months. One of these teachers described this level of use by stating, “We try to use it all the time, it’s not 100 percent, but we do use it most of the time.” Another group, comprised of three teachers, stated that they have used components of it but have not fully implemented it (one teacher was not asked this item). Two principals were not familiar enough with the learning cycle to answer the question. Two principals stated that the learning cycle was not being used to a large degree.

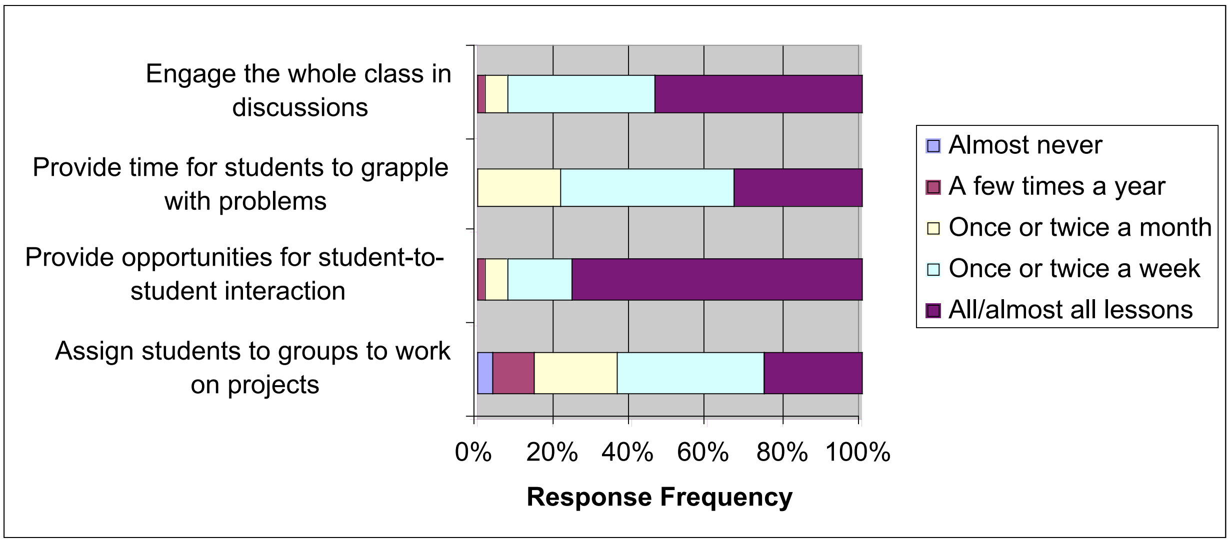
In summary, the observation data indicate that lessons reflect the instructional goals of the learning cycle at its introductory phases, but the interview data indicate that teachers are not yet implementing the learning cycle consistently and completely.

Student-Centered Learning

Whereas the previous section focused on the introductory phases of the learning cycle, this section addresses the student-centered approach or process that underlies every phase of the cycle. This approach assigns primary importance to student ideas, and provides opportunities for students to discuss their ideas together. The findings address the extent to which the science lessons encouraged student discussion and collaboration and promoted active student involvement. Overall, teachers and students perceive that science lessons reflect many student-centered principles, although classroom observation data present a more nuanced picture.

The teacher survey asked teachers to rate the frequency of four instructional practices aligned with student-centered learning. The overall frequency of responses is presented in Figure 8.

Figure 8. Frequency of Teacher Use of Instructional Strategies Supporting Inquiry Instruction



Overall, most teachers indicate that they are engaging in these student-centered practices on a daily or weekly basis. Three quarters of teachers state that they provide opportunities for student-to-student interaction in all or almost all lessons, and most of the remaining teachers do so on a weekly basis. Group work on projects was somewhat less frequent; a quarter of teachers state that they assign students to work in groups in all or almost all lessons, with another 38 percent stating they do so weekly. More than half of teachers state that they engage in whole class discussions in all or almost all lessons, and most of the remaining teachers do so on a weekly basis. Finally, one third of teachers state that they provide time for students to grapple with problems in all or almost all lessons and another 45 percent do so on a weekly basis.

The frequency of group project work differs by classroom type. Nearly three quarters of teachers in self-contained classrooms stated they did so (46 percent in almost all lessons, 27 percent weekly), whereas slightly more than half of teachers in nonself-contained classrooms did so (4 percent in almost all lessons, 50 percent weekly).

Students also reported their classroom characteristics and these findings indicate the prevalence of a student-centered approach. The items comprising the Involvement scale on the student survey asked students to rate statements about whether they are actively involved in sharing and discussing their ideas during their science lessons. As presented in Table 17, about half of all elementary students typically responded "yes" to items (of average difficulty) comprising the Involvement scale. About two fifths of high school students responded "yes" to items of average difficulty. More than 95 percent of elementary and high school students typically responded "yes" or "sometimes" to items of average difficulty on this scale. In summary, most students perceived that their science reflect involved learning (at least sometimes).

Table 17. Typical Responses of Elementary and High School Students to Items on the Involvement Scale

Involvement Scale Score	Elementary (*n* = 539)	High School (*n* = 350)
Yes	51.0%	41.4%
Sometimes	47.3%	53.7%
No	1.7%	4.9%
Total	**100.0%**	**100.0%**

Classroom observations were designed to provide an objective viewpoint about the degree to which lessons reflected student-centered learning. These observation data are presented in sections corresponding lesson design, instruction, and climate.

Lesson Design. Ratings of lesson design addressed whether the planned student activities promoted student-centered learning (see Table 18). Overall, lessons encouraged a collaborative approach to learning (item 1) but only somewhat provided time to make sense of experiences, compare ideas, and review what was learned (items 2–4, respectively). This finding reflects the comments of one teacher who stated that there often is not enough time to wrap up or review what was learned.

Table 18. Frequency of Ratings of Lesson Design Items

Lesson Design Items	Did Not Occur	Somewhat Descriptive	Very Descriptive
1. The design of the lesson encouraged a collaborative approach to learning.	0	3	8
2. Adequate time and structure were provided for students to make sense of their experiences.	3	4	4
3. Teacher provided time for students to compare their ideas with those of others and perhaps to revise their thinking.	4	3	4
4. Adequate time and structure were provided for "wrap up" (i.e., reviewing what was learned and how).	4	6	1

Note: $N = 11$.

Instruction. Ratings of instruction addressed the techniques used by teachers during lessons to foster student involvement and promote exchange of ideas (see Table 19). In general, raters did not frequently observe instructional techniques that promote student involvement. Teachers were not frequently observed inviting students to raise questions (item 1) or requesting evidence for explanations (item 2). The most commonly used technique was for teachers to ask questions to help students express understanding (item 4), which was observed in five lessons (combining "somewhat" and "very descriptive"). Several aspects of instruction, such as changing the focus of the lesson based on assessments (item 4) or student ideas (item 5), may not have been observable during a single class period. In summary, several instructional techniques for promoting student involvement were not prevalent.

Table 19. Frequency of Ratings of Instruction Items

Instruction Items	Did Not Occur	Somewhat Descriptive	Very Descriptive
1. Teacher invited students to raise their own questions.	8	1	2
2. Teacher requested justification (evidence) for students' explanations.	9	0	2
3. Teacher asked questions that helped students express understanding and explanations.	6	2	3
4. The lesson was modified as needed based on teacher questioning or other student assessments.	11	0	0
5. The focus and direction of the lesson was often determined by ideas originating with students.	11	0	0
6. Teacher encouraged students to use what they have learned to explain a new event or idea.	8	3	0

Note: $N = 11$.

Lesson Content. Two items on the observation protocol related to lesson content, as displayed in Table 20. In nine of 11 lessons (seven of which were "very descriptive"), students worked with models to represent and explore phenomena (item 2). This indicates that most teachers were presenting concepts in a manner that students can interact with and relate to. In five of 11 lessons, connections were made to other areas of science, disciplines, or contexts (item 1).

Table 20. Frequency of Ratings of Lesson Content Items

Lesson Content Items	Did Not Occur	Somewhat Descriptive	Very Descriptive
1. Appropriate connections were made to other areas of science, to other disciplines, and/or to real-world contexts.	6	1	4
2. Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	2	2	7

Note: $N = 11$.

Climate. Several observation protocol items focused on whether the overall climate of the lesson promoted student involvement and collaboration (see Table 21). In at least 10 of 11 classrooms, every item was rated as somewhat or very descriptive. In a majority of all classrooms, every item was rated as "very descriptive." Overall, the observed classrooms promoted student involvement and collaboration.

Table 21. Frequency of Ratings of Classroom Climate Items

Classroom Climate Items	Did Not Occur	Somewhat Descriptive	Very Descriptive
1. Active participation of all was encouraged and valued.	1	0	10
2. Interactions reflected collegial working relationships among students (e.g., students worked together, talked with each other about the lesson).	0	4	7
3. The teacher acted as a resource person, working to support and enhance student investigations.	1	4	6
4. There was a climate of respect for students' ideas, questions, and contributions.	0	3	8
5. The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions.	1	4	6

Note: $N = 11$.

Summary of Implementation of Learning Cycle

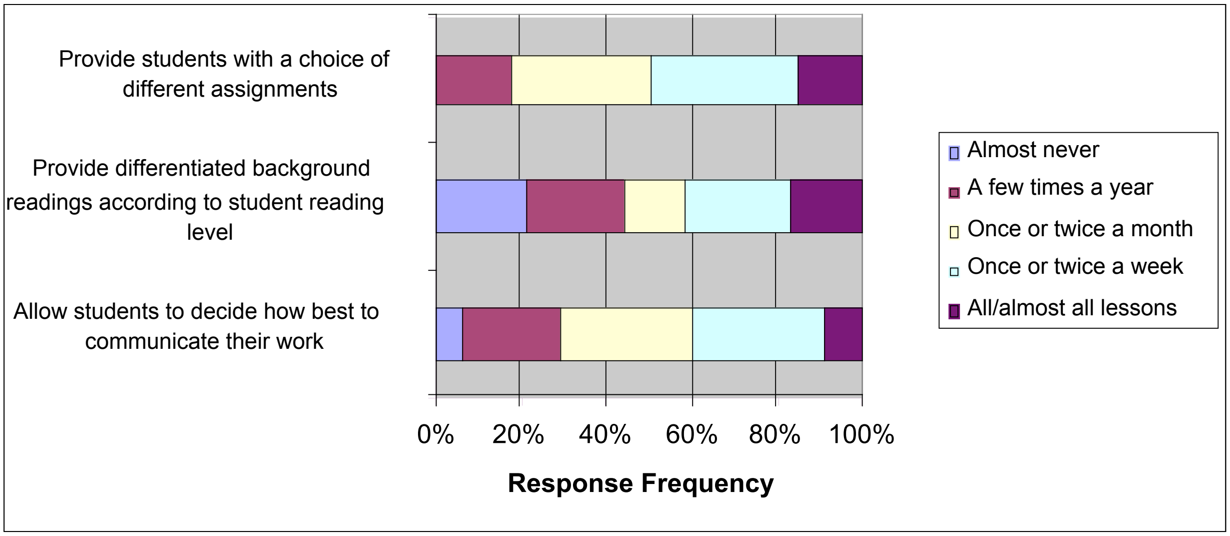
Many of the observed lessons appear to have been aligned with the early phases of the learning cycle. In particular, many lessons were designed to engage students and provide opportunities to explore phenomena. However, the full learning cycle is not yet implemented consistently by many teachers.

Teacher and student survey responses indicate that science lessons reflected student-centered principles somewhat to moderately frequently. The observed lessons provided opportunities for students to collaborate and to use manipulatives. Moreover, the climate of lessons encouraged participation of all students and was conducive to sharing of ideas. However, teachers typically did not use several instructional techniques for promoting student involvement and often did not allot much time for wrap-up or sense-making at the end of a lesson.

Differentiated Instruction

The teacher survey asked teachers to rate the frequency of instructional practices aligned with differentiated instruction. The overall frequency of responses is presented in Figure 9.

Figure 9. Frequency of Teacher Use of Instructional Strategies Supporting Inquiry Instruction



Less than one fifth of all teachers stated that they employed any of the differentiated instruction strategies on a daily basis. They most typically reported using the strategies on a weekly or monthly basis. Teachers of self-contained classes provided differentiated background readings more frequently (31 percent in all lessons, 31 percent weekly) than teachers of nonself-contained classes (4 percent in all lessons, 19 percent weekly).

According to interviews, there was relatively low use of differentiated instruction. Only one teacher reported using differentiated instruction for science. Two teachers stated that they have attempted to use it; however, they have not effectively done so. One teacher attributes any differentiation that occurs in the classroom to the students. She believes the students learn from each other and naturally differentiate. One teacher who was not differentiating instruction explained that he was confused about what it meant.

Barriers to Implementation

In interviews, teachers and principals described the following barriers to implementation of inquiry-based science instruction:

- Lack of time was the biggest barrier for five of the teachers. Time was needed to plan for lessons as well as time to implement a full cycle over several lessons. One teacher also mentioned the need for time to evaluate thoroughly the science books. Two principals also mentioned time as the main barrier.
- The second major barrier was resources. Three teachers found the instructional materials available to be a barrier, as they were not inquiry-based.
- Student absenteeism was a major barrier for one teacher who instructed juniors and seniors (who were often out of class for school activities).
- One teacher identified the lack of understanding of the learning cycle as an impediment.

(Principals were not asked specifically about barriers to implementation of the learning cycle.)

In addition to the interview comments, an item on the teacher survey asked respondents if they had experienced any barriers to implementing inquiry-based instruction. Fifty-four percent affirmed that there were barriers. Thirty teachers responded to an open-ended survey item to describe their barriers. Half of these responses referred to time as a barrier to implementation. Thirteen percent cited a lack of experience as a barrier to implementation, and 13 percent mentioned a lack of sufficient and effective curriculum materials. As one teacher explained, "I must adapt all lessons throughout the general science curriculum. This year that includes six grade levels."

Student Behavior

In interviews, seven teachers were asked how student behavior affected their use of inquiry instruction (this item was added to the protocol after the first site visit). Five teachers reported that student behavior did not interfere with inquiry. Most contended that the students behave fairly well because they are so engaged in the lessons they have no opportunity to misbehave. In those instances when the students misbehaved, they were easily redirected, according to the teachers. However, two teachers reported concerns about student behavior, such as damage to materials and a frequent need to discipline students for disruptive behavior.

Summary

Implementation of inquiry-based learning and the learning cycle is characterized by strengths and areas for improvement. Regarding the use of the essential features of inquiry, teachers frequently employed the features of asking scientific questions and gathering evidence (i.e., data collection and analysis). However, these features typically were not conducted in a student-centered manner. It appeared that lessons less frequently required learners to explain evidence, connect to scientific understanding, and communicate their findings. These features were much more prevalent in nonself-contained classrooms than self-contained classrooms. There were no differences between teachers from case study school teams and AEA teams in their reported frequency of implementation.

Regarding the use of the learning cycle, it appears that many lessons provided opportunities for students to engage with and explore questions and phenomena. Consistent with the student-centered approach of the learning cycle, active student involvement and collaboration appear to be prevalent. However, teachers infrequently used certain instructional techniques that promote student involvement, and often did not allot much time for wrap-up or sense-making.

Differentiated instruction did not appear to be widely implemented. It was somewhat more prevalent in self-contained classrooms than nonself-contained classrooms.

Lack of time for planning was the most frequently cited impediment to implementation. A minority of teachers also mentioned a lack of curriculum materials aligned with inquiry instruction.

Organizational Support

The evaluation addressed two questions related to organizational support:

- **Question 7:** To what extent does the administration advocate, facilitate, and support implementation?
- **Question 8:** To what extent are teachers participating in collaborative planning for inquiry?

This section reports findings of the analysis of three survey scales related to organizational support: principal support, professional learning, and resource availability. As described in the previous section, teachers from case study schools were anticipated to report greater organizational support than teachers affiliated with AEA teams. The analysis of each of the survey scales tested for this difference. The level of organizational support also was explored during interviews with principals and teachers. Because organizational support needs to be examined on the school level, teacher responses are grouped and reported by school.

Principal Support

On the survey, teachers rated the extent to which their principals understood of inquiry, communicated expectations, supported teacher collaborative planning sessions, and monitored implementation. The responses to these questions were combined into the Principal Support Scale, as described in the methods section. Using the Principal Support scale scores and the Rasch rating scale thresholds (the scaled transition points between adjacent categories), each teacher was classified according to his or her most likely response to an additional item of "average" difficulty. Such classification serves as a translation back from the scale score metric into the terminology of the survey. Table 22 shows the expected distribution of the teachers across the various rating categories. Teachers were split as to how supportive their principals were, with more than three fifths likely to report that their principal was not at all or only somewhat supportive.

Table 22. Teacher Ratings of Principal Support

Principal Support Scale Score	Count	Percent
Very much so	4	7.4%
Moderately	18	33.3%
Somewhat	9	16.7%
Not at all/slightly	23	42.6%
Total	**54**	**100.0%**

However, there appears to be a significant difference between the reports of the case study teachers, whose principals were directly involved in the program, and the AEA team teachers, whose principals were not directly involved. An independent samples *t* test indicated that Principal Support scale scores differed significantly between teachers from case study and AEA teams, $t(51) = 3.65$, $p < .001$. In terms of principal support, more than three quarters of teachers from case study schools were likely to respond “very much so” or “moderately,” compared to less than 30 percent of teachers from AEA teams.

The level of principal support was not significantly correlated with level of implementation.

The interview findings shed light on the high ratings of principal support among case study teachers. To begin with, three principals stated that they attended most or all of the ELI professional development workshops. All principals stated that their role in the ELI initiative is to provide the resources and materials that teachers need to implement inquiry. In the words of one principal, “[I] provide them the opportunity to learn about it [inquiry] and to attend the in-services.”

Apart from resources, the main avenue for principal support is to set expectations and provide accountability through monitoring. Three principals stated that they expect teachers to understand inquiry and implement it. Moreover, two principals stated that they monitor the implementation of inquiry by talking with teachers and observing classes. Two other principals stated that they do not monitor inquiry. Teachers in three schools agreed that their principal is supportive and does set expectations about implementing inquiry-based science. For example, in one school, the principal has provided direction to teachers to incorporate writing in inquiry instruction. However, in regard to monitoring, teachers from three schools stated that no one monitored implementation. Teachers in the fourth school stated that the principal monitored their implementation indirectly through meetings and informal discussions. In summary, principals appear to be setting expectations at three schools but doing informal monitoring at only one or two.

The interview comments explain the high degree of principal support indicated by case study teachers on their surveys. That is, most principals are knowledgeable about the ELI initiative (by virtue of their attendance at the workshops), provide necessary resources and materials, and set expectations. Some principals claim to monitor classroom instruction as well. However, relatively few teachers from the AEA teams perceived a high degree of principal support. This distinction highlights the importance of the characteristics of case study participation, where administrators participate in professional development alongside teachers and the school commits to supporting program implementation.

Professional Learning

The Professional Learning scale measured the extent to which teachers have support in place to help with their implementation of inquiry learning. This scale was comprised of five items related to teacher collaboration, discussions, classroom observations, and coaching. Teachers rated their agreement about whether these activities took place in their school to support the teaching of inquiry-based science. Using the Professional Learning scale scores and the Rasch rating scale thresholds (the scaled transition points between adjacent categories), each teacher was classified according to his or her most likely response to an additional item of “average” difficulty. Such classification serves to translate the scale score metric into the terminology of the survey. Table 23 shows the expected distribution of the teachers across the various rating categories. Only about 30 percent of teachers typically agree or strongly agree to items of this sort. This indicates that job-embedded professional learning, as measured by the Professional Learning scale, was not common at each school. There was no significant difference for case study and AEA team schools, as indicated by an independent samples t test, $t(51) = 1.56$, *ns*.

Table 23. Categorization of Teachers Based on Typical Responses to Professional Learning Items

Rating	Count	Percent
Strongly agree	1	1.9%
Agree	15	27.8%
Disagree	27	50.0%
Strongly disagree	11	20.4%
Total	**54**	**100.0%**

The limited reports of Professional Learning point to an area for future grown, as this scale is positively correlated with Implementation Frequency, $r\ (52) = .37$, $p < .01$.

Teacher interview comments provide additional details about the level of professional learning. Teachers in three schools described meeting with colleagues to plan science lessons. All teachers interviewed in each school discussed the difficulty in finding an opportunity to meet with colleagues to collaborate on lesson planning. For example, more than half of the teachers (across three of the schools) talked about needing to meet before and after school (and sometimes over the weekends) because they did not share common prep times. One teacher lacked any colleagues with whom to discuss science lessons. Principals at the case study schools were split as to whether they believed teachers had enough time for collaboration. Two principals agreed that there is little time for collaboration during the day, whereas two other principals stated that teachers have plenty of time throughout the day for collaboration.

In summary, teachers in the case study schools did participate in team meetings outside of the workshops. However, these meetings may have been difficult to arrange in some schools because many teachers (both case study and AEA) did not agree that there were opportunities for professional learning. Teachers who stated that they do have such opportunities are more likely to report greater frequency of implementation.

Resource Availability

The resources scale was comprised of several items referring to the adequacy of curriculum materials, laboratory supplies, and planning time. Using the Resources scale scores and the Rasch rating scale thresholds (the scaled transition points between adjacent categories), each teacher was classified according to their most likely response to an additional item of "average" difficulty. Such classification serves **to** translat**e** the scale score metric into the terminology of the survey.

Table 24 shows the expected distribution of the teachers across the various rating categories. It is evident that a majority of teachers do not agree that they have sufficient resources. An independent sample *t* test indicated that this scale score did not differ significantly between teachers from case study or AEA teams, $t(51) < 1$, *ns*.

Table 24. Categorization of Teachers Based on Typcial Responses to Resource Items

Rating	Count	Percent
Strongly agree	2	3.7%
Agree	20	37.0%
Disagree	23	42.6%
Strongly disagree	9	16.7%
Total	**54**	**100.0%**

The Resources scale correlated significantly with Implementation Frequency, $r\ (52) = .37$, $p < .005$. Thus, it appears that this is an important area for improvement.

Teacher interviews provide additional insight into these findings. At three schools the teachers and principals stated that the curriculum materials supported inquiry learning. The teachers at two schools noted that the hands-on learning activities provided by their materials work particularly well with an inquiry approach. In the fourth school, two teachers stated that the materials provide very little support for inquiry-based science instruction. The principal of this school reported using a text-based curriculum that was not aligned with inquiry. In summary, at least at the case study schools, the adequacy of curriculum resources was more positive than the survey scale would suggest.

At three of the schools in the case study, all teachers agreed that they modify the curriculum materials to be in alignment with the inquiry approach. One teacher expressed that it would be better to have materials that did not need to be "tweaked." In the fourth school the teacher stated that he did not modify materials at all.

In three schools the teachers stated that there was not an adequate amount of time to plan for inquiry lessons. In the fourth school, teachers held different conflicting opinions about the adequacy of planning time. These findings are consistent with the findings of the Resource scale. Perhaps, then, the relatively low ratings on this scale reflect an insufficiency of time resources rather than materials resources.

Correlations Among Survey Scales

As noted in the preceding sections, opportunities for professional learning and the adequacy of resources are correlated with level of implementation. It seems likely that the level of principal support is related to these other two measures of organizational support, because principals have a large degree of input into professional learning and resources. These three scales were correlated with each other to examine this relationship. As expected, principal support was positively correlated with both professional learning ($r = .67$, $p < .001$) and resources ($r = .27$, *p*

< .05). This indicates that teachers who perceived high degrees of principal support also tended to perceive ample opportunities for professional learning and sufficient resources. The correlation among all scale scores is presented in Appendix I.

Summary

This section examined three aspects of organizational support: principal support, opportunities for professional learning, and adequacy of resources. The findings are based on survey scale scores and interviews with teachers and principals. In regard to principal support, there was a distinction based on team affiliation. Teachers from case study schools typically perceived their principals as supportive of inquiry, whereas teachers from AEA teams typically did not. This difference was anticipated based on the fact that case study principals were expected to attend the professional development workshops and commit to supporting implementation at their respective schools.

Interviews with case study participants indicated that principal support is manifest in providing time to attend professional development workshops, communicating expectations, and in some schools, monitoring implementations. However, monitoring of implementation does not appear to be widespread or formalized.

Across all teachers participating in ELI, only a minority confirmed the presence of professional learning opportunities such as teacher collaboration, coaching, and modeling. Interviews with participants in case study schools indicated that there were regular planning meetings among the science faculty, but the amount of time for teacher collaboration was not sufficient to plan inquiry-based lessons.

Many teachers in the program do not perceive that they have sufficient resources for inquiry learning. Interview comments indicated that material resources are adequate for most teachers, but that planning time typically is lacking. Although curriculum materials in three of the case study schools support inquiry well, many teachers modify their materials to align better with the inquiry approach.

Higher levels of principal support were associated with higher ratings of professional learning and resource adequacy. The latter two constructs, in turn, were associated with more frequent implementation of inquiry learning.

Student Learning

The ultimate goal of the ELI program is to improve the quality of student learning in science. This section serves to answer four questions about this impact:

- **Question 9:** To what extent have students acquired the abilities and fundamental understandings about scientific inquiry?
- **Question 10:** What is the impact on student enthusiasm and self-efficacy toward science learning?
- **Question 11:** Are the scientific understandings and abilities of students improving?
- **Question 12:** Does the program address the needs of all subgroups?

The data used to address these questions include teacher and principal interviews and teacher and student surveys. Collection of student achievement data is underway to answer the impact on scientific knowledge (Question 11) and will be presented in a forthcoming impact report. The present report presents the opinions of teachers and principals about this impact.

Impact on Student Understanding of Scientific Concepts and Science Inquiry

On their survey, teachers rated the extent to which their use of inquiry-based instruction had improved student understanding of scientific concepts and understanding of the scientific inquiry process. Overall, at least two thirds of all teachers agreed that inquiry had improved all of these student outcomes, as summarized in Table 25.

Table 25. Impact of Inquiry-Based Science Instruction on Student Learning

To what extent do you think your use of inquiry-based instruction has improved the Following for Your Students:	*N*	Not at All/ Slightly	Somewhat	Moderately	Very Much So
Understanding of the scientific inquiry process	52	1.9%	30.8%	28.8%	38.5%
Understanding of scientific concepts	53	1.9%	20.8%	37.7%	39.6%

- About two thirds of teachers reported that inquiry-based instruction has improved the understanding the scientific inquiry process for their students “very much so” (38 percent) or “moderately” (29 percent).
- About three quarters of teachers reported that inquiry-based instruction has improved the understanding the scientific concepts for their students “very much so” or “moderately.” However, teachers in self-contained classrooms reported a greater extent of improvement relative to teachers in nonself-contained classrooms. Among the former group, 48 percent stated it had improved “very much so,” compared to 31 percent of teachers in nonself-contained classrooms.

During interviews, teachers were asked to describe the extent to which students are able to engage in the process of scientific inquiry. Nine of ten teachers stated that the students were engaged in the process of scientific inquiry. However, several teachers spoke in general terms about engaged learning, rather than about student ability to conduct scientific inquiry. Two teachers did state directly that their students are able to conduct inquiry-based investigations. One of these teachers illustrated the ability of her students to conduct investigations:

> We spent some time discovering the concept of density. Then they were to design an experiment where they could compare the density between regular soda pop and diet soda…I did not give them instructions…they solved it their own way.

Teachers were asked to describe how their implementation of inquiry-based science instruction had affected the way their students learn science. Although seven teachers stated that inquiry had had a positive impact on student learning, most of these comments focused on student engagement rather than on the understanding of scientific concepts per se. However, two teachers reported that students' understanding improved with inquiry. One of these teachers explained that inquiry learning has promoted critical thinking. This teacher stated:

> They understand what's happening more, they understand what they're seeing or observing or what's gone on. They're better thinkers, they're more critical in other classes because of some of the thinking skills that we do in here.

Meeting the Needs of All Students

During interviews, teachers were asked to describe whether the ELI initiative was meeting the needs of all students. Nine of ten teachers stated that the ELI program did indeed met the needs of all of their students. Many teachers noted that students with special needs were able to engage in the learning process as well as the higher-achieving students. Most of these comments referenced Special Education students and struggling students (i.e., those who had difficulty grasping science). During the interview a teacher indicated, "My resource and my [behavioral disorder] students often outshine my English Language Program students."

Several teachers reported that inquiry improved the self-efficacy of low-achieving students. Some respondents suggested that inquiry-based instruction was better suited to teach low-achieving students than a more traditional approach. One teacher stated:

> We found the more needy children, the lower end kids do a lot better in the inquiry process than traditional means because they do not have to rely on memorizing things or get things just by reading or listening, their free to just try it.

All four principals' answers were consistent with the teacher responses, and they each believe that the program addresses the needs of all students.

The student survey also yielded findings that are relevant to the question of self-efficacy. However, the survey items addressing self-efficacy did not cohere into a single scale. As a result, they are presented individually in Table 26. As indicated by the proportion of students responding "yes," nearly three quarters of elementary students and slightly more than half of high school students considered themselves good science students. More than two-thirds of elementary students and slightly more than half of high school students expected to "do well in science in high school or college." Slightly more than half of all students expected to be know how to collect data to answer a scientific question.

Table 26. Frequency of Student Responses to Items about Science Self-Efficacy

Elementary (*n*=539)	**Yes**	**Sometimes**	**No**	**Missing**
I consider myself a good science student.	74.2%	21.5%	4.1%	0.2%
I would probably do well in science in high school or college.	67.9%	22.3%	9.5%	0.4%
If my teacher asked me to collect data to answer a question, I would know how to do it.	55.5%	37.5%	6.7%	0.4%
High School (*n*=351)	**Yes**	**Sometimes**	**No**	**Missing**
I consider myself a good science student.	54.4%	36.8%	7.7%	1.1%
I would probably do well in science in high school or college.	52.4%	29.3%	17.1%	1.1%
If my teacher asked me to collect data to answer a question, I would know how to do it.	53.6%	39.3%	6.0%	1.1%

Impact on Student Attitudes Toward Science

In addition to enhancing student understanding of science, the ELI initiative sought to enhance student attitudes toward science as well. The teacher survey asked respondents to rate the extent to which their use of inquiry-based instruction had improved student engagement and enthusiasm. As displayed in Table 27, most teachers described at least a moderate impact on these attitudes.

Table 27. Impact of Inquiry-Based Science Instruction on Student Learning

To What Extent Do You Think Your Use of Inquiry-based Instruction Has Improved the Following for Your Students	**N**	**Not at All/Slightly**	**Somewhat**	**Moderately**	**Very Much So**
Active engagement in science lessons	53	1.9%	17.0%	26.4%	54.7%
Enthusiasm in science	53	3.8%	9.4%	28.3%	58.5%

- Four fifths of all teachers reported that inquiry-based instruction improved the level of active engagement in science lessons "very much so" (55 percent) or "moderately" (26 percent).
- More than 85 percent of teachers stated that inquiry-based instruction improved the level of enthusiasm in science "very much so" or "moderately." However, teachers in self-contained classrooms reported a greater extent of improvement in enthusiasm, with two

thirds stating it had improved "very much so" compared to about half of teachers in nonself-contained classrooms stating it had improved "very much so."

During interviews, teachers were asked to describe any changes in attitudes they have noticed in their students. Seven teachers reported an increase in the level of enthusiasm and engagement about science. One teacher stated that this was evident by the increase in the number of student questions and the conversations they have about the lessons. Another respondent described the increase in enthusiasm, saying:

> Our kids like science and they really and truly are showing that more. They look forward to when I put science up to be in the morning instead of the afternoon…They're enthusiasm for science is definitely better as a result of this kind of learning.

Still another teacher stated that he or she received good feedback from parents regarding inquiry learning. Parents were impressed with the enthusiasm students displayed for science. All four principals stated that the introduction of inquiry learning has improved the level of student engagement. Two of these principals stated that engagement was already high, but that it has further increased. One principal stated that the interest in science has "skyrocketed."

The student survey also indicated high levels of liking of science, but only among elementary students. The student survey presented a series of questions about their liking of science (e.g., "I look forward to science lessons"). These items had the psychometric properties necessary to combine into a single scale. Table 28 presents the proportion of students that was likely to respond "yes," "sometimes," or "no" to statements about liking of science. Seventy percent of elementary students were likely to agree with statements about the liking of science, indicating that most elementary students like their science classes. Less than one fifth of high school students were likely to respond "yes" to items about the liking of science. The level of liking will be tracked over time to observe the impact of the initiative.

Table 28. Proportion of Students Likely to Respond with Different Response Options to Items About Liking of Science

Response	Elementary (n = 538)	High School (n = 348)
Yes	70.4%	17.8%
Sometimes	25.1%	55.5%
No	4.5%	26.7%

Summary

Teachers and principals perceived that inquiry-based science instruction promoted engaged learning and student interest. Currently, most elementary students demonstrate a high degree of liking of science, but few high school students demonstrate a strong liking. Most elementary students have positive views about their abilities in science, whereas among high school students such views are held only by a simple majority.

Most teachers reported that their use of inquiry learning has had a positive affect on student understanding of scientific concepts and scientific inquiry. Teachers differed in their ratings based on classroom type. Relative to teachers in nonself-contained classrooms, teachers in self-contained classrooms reported a greater extent of improvement in both understanding of scientific concepts and enthusiasm toward science.

It appears that the program addresses needs of all students, and in fact has improved the self-efficacy and learning of students who had previously struggled academically. Overall, teachers reported that inquiry provides low-achieving students with the opportunity to better engage with the lessons, and consequently improved their self-efficacy. Overall, a majority of students exhibited self-efficacy toward science learning.

Summary and Recommendations

Questions About Reactions to Professional Development

1. What were teacher perceptions of the quality, utility, and relevance of the workshops?

Most teachers were satisfied with the quality of the professional development sessions, and described the interactivity and opportunities to collaborate as strengths. A majority of teachers indicated that the professional development prepared them to implement inquiry-based learning and teach to heterogeneous groups. Nevertheless, a substantial minority (more than 35 percent) did not state that the professional development prepared them for these tasks. Half the teachers stated that it prepared them to align inquiry-based lessons to local standards. Only a minority (40 percent or less) reported that the professional development had prepared them to assess student work and differentiate instruction.

2. In what ways should the professional development be improved?

The most consistent recommendation for improvement of the professional development workshops was to provide even more opportunities for team-based planning and collaboration. The workshops should provide more explicit direction about what aspects of the initiative should be implemented when.

Questions About Participant Learning

3. To what extent do teachers have self-efficacy to implement inquiry learning?

Most teachers rated a moderate level of self-efficacy for implementing the learning cycle.

4. To what extent do participants have a fundamental understanding about scientific inquiry?

In interviews, most teachers described a working knowledge of inquiry-based instruction. All teachers professed at least a working knowledge of the learning cycle. Teachers of nonself-contained classes understood the *NSES* better than teachers of self-contained classrooms, as expected. This probably reflects the fact that the former are full-time science teachers and were more familiar with the *NSES* to begin with.

Questions About Changes in Teacher Practice

5. To what extent are teachers implementing inquiry learning?

Implementation of inquiry-based learning and the learning cycle is characterized by strengths and areas for improvement. Regarding the use of the essential features of inquiry, teachers frequently employed the features of asking scientific questions and gathering evidence (i.e., data collection and analysis). However, these features typically were not conducted in a student-centered manner. It appears that lessons less frequently required learners to explain evidence, evaluate their explanations in light of alternative explanations, and communicate their findings. The latter two features in particular were more prevalent in nonself-contained classrooms than self-contained classrooms.

Regarding the use of the learning cycle, it appears that many lessons provided opportunities for student to engage with and explore questions and phenomena. Consistent with the student-centered approach of the learning cycle, active student involvement and collaboration appear to be prevalent. Teachers infrequently used certain instructional techniques that promote student involvement, and often did not allot much time for wrap-up or sense-making.

Differentiated instruction did not appear to be widely implemented. It was more prevalent in self-contained classrooms than nonself-contained classrooms, perhaps owing to the greater familiarity of teachers in self-contained classrooms with the reading levels of their students.

6. What are the factors that inhibit and facilitate implementation?

Most participants cited the lack of time for planning and resources as the main impediments to implementation.

Questions About Organizational Support

7. To what extent does the administration advocate, facilitate, and support changes in teacher practice?

In the case study schools, teachers reported that their principals are supportive of inquiry. This support is manifest in providing time to attend professional development workshops; communicating expectations; and, in some schools, monitoring implementation. Teachers from the case study schools report higher levels of principal support than teachers with the AEA teams. This difference was expected based on the fact that case study principals were expected to attend the professional development workshops and commit to supporting implementation at their respective schools.

Teachers and principals in three case study schools reported that materials support inquiry well, but in the fourth school they reported that they did not. Even where the materials were aligned, many teachers reported that they needed to modify their materials to support an inquiry approach. Among all teachers in the program, many report they do not have sufficient resources for inquiry learning. Interview comments indicated that curriculum materials are adequate for most teachers, but that planning time typically is lacking.

8. To what extent are teachers participating in collaborative planning for inquiry?

Among all teachers participating in ELI, a majority reported insufficient time for collaboration. On the survey, only a minority confirmed the presence of teacher collaboration and job-embedded professional development in support of inquiry learning. Teachers in case study schools report regular planning meetings among the science faculty. However, these teachers also stated that the amount of time for teacher collaboration is not sufficient to plan inquiry-based lessons. The presence of teacher collaboration and job-embedded professional development is related to the frequency of implementation, as rated by teachers.

Higher levels of principal support were associated with higher ratings of professional learning and resource adequacy. The latter two constructs, in turn, were associated with more frequent implementation of inquiry learning.

Questions About Student Learning

9. To what extent have students acquired the abilities and fundamental understandings about scientific inquiry?

Two thirds of teachers stated on the survey that inquiry-based instruction has improved the understanding the scientific inquiry process for their students.

10. What is the impact on student enthusiasm and self-efficacy toward science learning?

Teachers and principals reported that inquiry learning promoted engaged learning and student enthusiasm about science. Teachers in self-contained classrooms, relative to those in nonself-contained classrooms, reported a greater extent of improvement in enthusiasm toward science. In elementary schools, students reported a high degree of liking of science and have positive views about their abilities in science. However, few high school students indicated strong liking, and just more than half reported having positive views about their abilities in science.

11. Are the scientific understandings and abilities of students improving?

Most teachers reported inquiry-based science instruction as having a positive affect on student learning. Teachers in self-contained classrooms, relative to those in nonself-contained classrooms, reported a greater extent of improvement in student understanding of science concepts. Objective evidence regarding the impact on scientific understanding will be included in a forthcoming report about the impact on student achievement.

12. Does the program address the needs of all subgroups?

Teachers report that the program addressed needs of all students, and, in fact, improved the self-efficacy and learning of students who had previously struggled academically. Overall, teachers reported that inquiry provides low-achieving students with the opportunity to better engage with the lessons and improved their self-efficacy.

Recommendations

The findings from this report provide the basis for several recommendations for strengthening the ELI initiative. These recommendations correspond to the major impediments and teacher needs that were identified. The overarching concern is the need to provide ongoing support to teachers as they attempt to implement what they learn about inquiry instruction. Teachers identified a need for more planning time, better resources, and clearer direction about what and how they should teach according to the model. Teachers also reported somewhat low levels of professional learning opportunities.

Continual support for implementation

Based on these needs, the ELI initiative should provide guidance to schools on establishing job-embedded and classroom-based professional learning opportunities. Given that the presence of professional learning activities was correlated with more frequent implementation, support for implementation ought to include classroom-based support such as coaching and modeling. ELI project staff should offer guidelines to schools about the frequency and format of this support. Case study schools may consider providing release time to a particular teacher who would devote time to classroom-based support. By the same token, it would be helpful if a member of the ELI instructional team (or some other science instructional consultant) could visit each case study school to provide classroom-based support.

Teachers also stated that they would like more time to collaborate with one another during workshops. As such, workshops should provide opportunities for increased team-based planning and collaboration, possibly using the April 2007 workshop as a model.

Clarity of implementation goals

The ELI design team should communicate goals and benchmarks for implementation more clearly to the case study schools. Clarifying what aspects of inquiry learning should be implemented, and when, would necessitate providing more direction to participants about how to implement these aspects, and would thereby address a separate concern of some participants.

Topics of professional development

While the professional development offered generally was given favorable reviews, there is room for improvement in terms of implementation of the full inquiry cycle, the use of student-centered instructional practices, and providing time for wrap-up and sense making. Only a minority of teachers indicated that the professional development had prepared them to assess student work or differentiate instruction. Additional professional development in these areas should be considered.

Results also point toward a need for more differentiated professional development, as there were some differences between responses from self-contained and nonself-contained teachers. Teachers of nonself-contained classrooms infrequently differentiated science instruction. These teachers would benefit from greater discussion of how to differentiate instruction in nonself contained classrooms

In general, the topics of the workshops should be responsive to feedback from teachers about their areas of need. Visits from the instructional staff to case study schools (i.e., to provide classroom-based assistance) would provide a useful source of information about these areas of need.

Needs of AEA teacher leaders

Although the main focus of the evaluation is on the experience of case study schools, it is evident that the teacher leaders from the AEA teams are at a disadvantage when it comes to organizational support. If these teacher leaders are unable to engage in professional learning activities to support their own implementation, then their capacity to train other teachers may be compromised. Although there are no clear recommendations to offer based on this report, the issue warrants further consideration.

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Appendix A.
Essential Features of Classroom Inquiry and Their Variations

Essential Feature	Variations			
Learner engages in scientifically-oriented questions	Learner poses a question	Learner selects among questions, poses new questions	Learner sharpens or clarifies a question provided by the teacher, materials, or other source	Learner engages in a question provided by the teacher, materials, or other source
Learner gives priority to evidence in responding to questions	Learner determines what constitutes evidence and collects it	Learner is directed to collect certain data	Learner is given data and asked to analyze	Learner is given data and told how to analyze
Learner formulates explanations from evidence	Learner formulates explanations after summarizing evidence	Learner is guided in process of formulating explanations from evidence	Learner is given possible ways to use evidence to formulate explanation	Learner is provided with evidence
Learner connects explanations to scientific knowledge	Learner independently examines other resources and forms the links to explanations	Learner is directed toward areas and sources of scientific knowledge	Learner is given possible connections	
Learner communicates and justifies explanations	Learner forms reasonable and logical argument to communicate explanation	Learner is coached in development of communication	Learner is provided broad guidelines to use to sharpen communication	Learner is given steps and procedures for communication

More ← Amount of Learner Self-Direction → Less
Less ← Amount of Direction from Teacher or Material → More

Source: National Research Council. 2002. *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*. Washington, D.C.: National Academy Press.

Appendix B.
Instrument Design and Validation

Teacher Survey

Learning Point Associates developed a teacher survey to address four of the five levels of the evaluation: teacher learning, organizational support, implementation of inquiry instruction, and student impact. It did not address the fifth – professional development. The teacher survey was based on the *2000 National Survey of Science and Mathematics Education* developed by Horizon Research Incorporated (HRI). The HRI teacher survey was revised and adapted for this evaluation based on discussions with the ELI design team. Several items were added to the survey to align with the goals of the ELI initiative. The following paragraphs described the different sections of the teacher survey.

Background information. Several background items asked about teacher educational level and teaching experience. The remaining background items elicited information about the teacher's classroom, including grade level, whether the class was self-contained or not, the subject of the class (if not self-contained), students characteristics, and types of materials. Teachers of classes that were not self-contained were asked to answer the survey while considering a typical class of theirs.

Teacher learning. The teacher survey addressed the following aspects of teacher learning:

- A single item asked teachers to describe their level of understanding of the *NSES.*
- Six items asked teachers to rate their self-efficacy in terms of implementing the learning cycle. These items were all stems introduced by the question, "To what extent do you feel prepared to deliver science lessons that do the following?" Teachers rated their self-efficacy using the response options of *Not at all/Slightly prepared, Somewhat prepared, Moderately prepared*, and *Very prepared*. The items that comprised this scale are as follows:
    - Elicit responses to discover what students know or think about a concept
    - Engage student interest in a scientific concept or problem
    - Introduce scientific terms or concepts that help students explain previous experiences
    - Provide common experiences for students to test their own ideas about a problem and compare them to others
    - Provide experiences that challenge the current conceptions of students
    - Provide opportunities for students to apply developing concepts to new situations
- Five items asked teachers to rate the extent to which the ELI professional development prepared them to accomplish several broad instructional tasks. These tasks were to implement inquiry learning, to teach inquiry to groups in heterogeneous ability, to differentiate instruction while doing inquiry, to evaluate student work from inquiry based lessons, and to align inquiry lessons to state standards. These items were rated with the

response options of *Not at all/Slightly, Somewhat, Moderately,* and *Very much so*. Because these items represent independent constructs, they were not combined into a single scale score (and are analyzed independently).

Organizational Support. The survey included three groups of items that were used to create scales addressing job-embedded professional development, principal support, and resources. Each scale is described in more detail below.

- Five items asked teachers to rate their level of agreement with statements about professional learning opportunities in their school. These items were introduced with the statement, "Rate your agreement with the following statements about science teaching in your school:" Teachers rated their agreement with the response options of *Strongly Disagree, Disagree, Agree, Strongly Agree*. The items that comprised this scale are as follows:
  - Administrators regularly observe classrooms to monitor implementation of inquiry learning.
  - Science teachers in this school regularly observe each other teaching classes in order to learn how to implement inquiry-based lessons.
  - Teachers meet following ELI professional development sessions to discuss or plan implementation.
  - Teachers meet to examine student work (e.g., to study the effectiveness of inquiry lessons).
  - Teachers receive in-school coaching and/or modeling to support inquiry-based instruction.
- Four items asked teachers to rate the extent to which administrators support inquiry learning. The items were introduced with the stem, "To what extent does your principal, assistant principal, or department head:" These items were rated with the response options *of Not at all/Slightly, Somewhat, Moderately, and Very much so*. The items that comprised this scale are as follows:
  - understand inquiry-based instruction
  - communicate expectations about implementing inquiry learning
  - encourage teacher collaboration to support inquiry learning (e.g., lesson planning, observing lessons, reviewing student work, etc.)
  - monitor teacher implementation of inquiry learning.
- Five items asked teachers to rate their agreement with statements about resources. These items were introduced with the statement, "Rate your agreement with the following statements about your teaching resources for inquiry learning:" Teachers rated their agreement with the response options of *Strongly Disagree, Disagree, Agree, Strongly Agree*. The items that comprised this scale are as follows:
  - I have adequate laboratory space and lab equipment to support inquiry-based learning.

    - I have enough well-stocked science kits or boxes to support inquiry-based learning.
    - I have instructional materials that align with inquiry-based learning.
    - I have sufficient planning and preparation time to create inquiry-based lessons.
    - I have time during the regular school week to work with my colleagues on implementation of inquiry-based learning.

Implementation of Inquiry Learning. Several items examined the frequency with which teachers used certain strategies, or that students engaged in certain activities, that align with or support inquiry-based learning. Frequency was rated using the following response options: *Almost never, A few times a year, Once or twice a month, Once or twice a week, All or almost all lessons*. There were three groups of items of this type:

- To create a single scale of frequency of implementation of inquiry-based instruction, teachers rated the frequency with which students in their class took part in nine[1] types of science activities aligned with the essential features of inquiry learning. These items were introduced with the statement, "About how often do students in this class take part in the following types of science activities?" The items that comprised this scale were as follows:
    - Critically examine the scientific explanations of other students.
    - Explain their findings and conclusions to other students.
    - Plan investigations to answer scientific questions.
    - Prepare written science reports.
    - Record, represent or analyze data.
    - Support their explanations with scientific knowledge.
    - Use data to support an explanation.
    - Work on extended science investigations or projects (a week or more in duration).
- A single item asked teachers to rate the extent to which they are currently implementing inquiry learning. The response options ranged from *Not at all* to *Very much so* (as described previously). Each response option was defined in terms of the number of essential features that the teacher used. For example, the option *Somewhat* was accompanied by the description, "Some [essential] features with some variations."
- Teachers rated the frequency with which they differentiated instruction by responding to three separate items. A typical items of this sort was, "Allow students to decide how best to communicate their work." It was not possible to create a scale of differentiated instruction due to the insufficient number of items.
- Teachers rated the frequency with which they used four different student-centered instructional techniques that support inquiry-based instruction. An example of an item of this type was, "Assign students to work in groups on projects." Because these items don't

[1] A tenth survey item was omitted due to a clerical error.

relate clearly to an overarching construct, they were not combined into a single scale score.

- Finally, a single item asked teachers if they experienced any barriers to implementation, and if so, to describe the barriers in an open-ended fashion.

Impact on Student Learning. Four items asked teachers to rate the extent to which their implementation of inquiry learning has improved student learning outcomes. These outcomes were engaged learning, understanding of science concepts, enthusiasm, and understanding of inquiry. These items were not combined into a single scale because they corresponded to independent constructs. Teachers rated the extent of improvement with the response options of *Not at all/Slightly, Somewhat, Moderately*, and *Very much so*.

Baseline Attitudes about Teaching Science. In addition to the foregoing topics, two items asked teachers to rate their agreement with statements about their enjoyment of teaching science and about their perception of their teaching ability. The purpose of these items was to establish baseline attitudes about science teaching, in order to be able to track how these change across the years of the program.

Survey Administration

In mid-March 2007, Learning Point Associates emailed each participating teacher asking them to complete the survey via the Internet. At the request of Learning Point Associates, the director of the ELI initiative also sent a message to each participant asking them to respond to the survey. The survey remained open for three weeks. Evaluators sent two follow-up messages directly to non-respondents, and also contacted the principals at case study schools to request that they remind all teachers to complete the ELI survey if they had not already done so. ELI project staff also sent a reminder message to non-respondents encouraging their participation. Of the 83 teachers who were contacted, a total of 53 teachers completed the survey, for an overall response rate of 64 percent. See Table 1 for a breakdown of respondents by school type.

Table 1. Respondents by Case Study School

School	Num. Teachers	Surveys Completed	Rate
Case study schools	21	14	66.6%
Non-case study schools	62	39	62.9%
Total	**83**	**53**	63.8%

Survey Validation

As described above, the survey included items intended to capture five constructs: self-efficacy, job-embedded professional development, principal support, resources, and implementation. A psychometric analysis confirmed that the items could be combined to form valid and reliable measures of each construct.

There are several advantages to creating scales from groups of survey items. Multiple items that measure a single construct often tap different aspects or dimensions of the construct. Therefore, a good scale more fully captures the construct. In addition, a single scale is also easier to interpret than group of single items.

The primary method used for survey item analyses was the Rasch model for ordered categories (Andrich, 1978; Rasch, 1980; Wright & Masters, 1982; Wright & Stone, 1979) implemented with WINSTEPS (Linacre, 2004), a statistical software program. Rasch models may be used to solve a variety of measurement problems (Smith & Smith, 2004; Wright, 1977). For example, Rasch models can be used for locating persons (principals) and survey items on the same latent continuum or metric; for understanding the structure of items; and for setting standards, equating, and differential-item functioning to name just a few applications. Once the parameters of the Rasch model were estimated, they were used to calculate a set of scale scores for each of the five constructs.

When implemented properly, Rasch models overcome the limitations of Classical Test Theory (Smith & Smith, 2004; Wright, 1977), such as (1) the sample dependency of item and person estimates, (2) the lack of procedures for determining how measurement error varies across the levels of the latent trait, (3) the inability to directly compare scores obtained from the same set of items unless complete data are available, (4) the ordinal nature of the scores (Rasch scores possess interval qualities and are continuous), and (5) the lack of techniques for validating response patterns.

When the data fit the model requirements, the person measures and item calibrations appear on a common logit scale (Perline, Wright, & Wainer, 1979; Rasch, 1980). Creation of a common scale allows the calculation of a probabilistic outcome of an interaction between any person and any item (e.g., the probability of selecting a rating scale category). As a result, it is possible to identify which response category a person can be expected to endorse for a given item.

The Rasch model used in item analyses orders items in terms of the difficulty of endorsing each item. For example, for one of the Principal Support items, nine percent (n=5) of respondents on the survey reported that their principal "Communicates expectations about implementing inquiry learning." In the Rasch analysis, this item was thus identified as relatively difficult to endorse. In computing scale scores for each construct, the Rasch model adjusts for the difficulty of endorsing each of the items composing the scale.

Student Survey

The student survey was developed by Learning Point Associates based on items from the following existing instruments. Items from the What is Happening in this Classroom (WIHIC; Fraser, Fisher, & McRobbie, 1996) survey were used to address the constructs of investigation and involvement. These constructs are used to evaluate the level of implementation of inquiry-based instruction, because they closely align with the type of activities and instructional styles promoted by the professional development. A sample item from the Investigation scale of the WIHIC is, "I carry out investigations to test my ideas." A sample item from the Involvement scale of the WIHIC is, "I talk with other students about how to solve problems."

Items from the Test of Science Related Attitudes (TOSRA; Fraser, 1982) were used to measure a student's enjoyment of science. A sample item of this sort is, "I look forward to science lessons." Items from an instrument developed by Simpson and Troost (1982) were used to measure self-confidence in science; additional items for this construct were written by the evaluators. All items on the survey had a response scale of Yes, No, and Sometimes. This differed from the scales used in each the original instruments, which had a greater number of response options. This purpose of this change was to simplify the response scale to accommodate younger survey participants.

Observation Reliability

Eleven of the twelve observations were conducted with two independent raters, one of whom was the principal investigator. The one observation that was conducted by a single rater was not included in the analysis. Interrater reliability was determined for each item as the percentage of the eleven observations for which both agreed. Raters identified the reason for the discrepancies and resolved disagreements by clarifying what occurred during the observed lesson or clarifying the underlying meaning and boundaries of the feature being rated.

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Appendix C.
Teacher Survey

Section A: Teacher Background

1. Select the highest degree you have earned?
    a. Associates
    b. Bachelors
    c. Masters
    d. Doctorate
2. Please indicate the subjects for each of your college degrees (select all that apply).
    a. Biology/Life Sciences
    b. Chemistry
    c. Earth/Space Sciences
    d. Physics
    e. Other Science
    f. Science education (any science discipline)
    g. Mathematics/Mathematics Education
    h. Elementary Education
    i. Other Education (e.g., History Education, Special Education)
    j. Other, please specify
3. Do you teach in a self-contained class? (i.e., you teach multiple subjects to the same class of students all or most of the day.)

    Yes/No

    Skip logic notes:
    [Yes: complete items 5 and 6, skip items 7 and 8]
    [No: skip items 5 and 6, complete items 7 and 8]
4. How familiar are you with the *National Science Education Standards*, published by the National Research Council? (Not at all familiar, Somewhat familiar, Fairly familiar, Very familiar)

(Items for Teachers of Self-contained Classes)

5. Many teachers feel better qualified to teach some subject areas than others. How well qualified do you feel to teach each of the following subjects **at the grade level(s) you teach**, whether or not they are currently included in your curriculum? **Scale**: Not well qualified, adequately qualified, very well qualified

   Life science

   Earth science

   Physical science

   Mathematics

   Reading/Language Arts

   Social Studies

6. We are interested in knowing how much time your students spend studying science. In a typical week, how many days do you have science lessons, and how many minutes long is an average lesson?

   Days per week (1–5)

7. Approximate minutes per day (1–15, 16–30, 31–45, 46–60, 61–75, 76–90)

(Items for Teachers of non-contained science classes)

8. What is the usual schedule and length (in minutes) of daily class meetings for this class?

   Days per week (every day, every other day, other)

9. Number of minutes per day

   34 or fewer, 35–44, 45–54, 55–64, 65–74, 75 or greater

10. What is the content area of this course?

    a. Biology/Life Sciences
    b. Chemistry
    c. Earth/Space Sciences
    d. Physics
    e. Other Science

Section B: Your Science Teaching in a Particular Class

The questions in this section are about a particular science class you teach. If you teach science to more than one class per day, please select the class that you teach that is most typical of science classes in your school (in terms of the academic level of the students).

11. Please indicate the grades of the students in this class (select all that apply):

    K–12

12. What is the total number of students in this class?

13. Which of the following best describes the ability of the students in this class relative to other students in this school?

    a. Fairly homogeneous and low in ability
    b. Fairly homogeneous and average in ability
    c. Fairly homogeneous and high in ability
    d. Heterogeneous, with a mixture of two or more ability levels

14. Indicate how many students in this class are **formally** classified as each of the following:

    None

    1-5 students

    6-10 students

    11-20 students

    More than 20

    a. Limited English Proficiency
    b. Special Education

15. About how often do you do each of the following in your science instruction?

    Almost never

    A few times a year

    Once or twice a month

    Once or twice a week

    All or almost all lessons

    a. Assign students to work in groups on projects
    b. Provide opportunities for student-to-student interaction
    c. Provide time for students to grapple with problems
    d. Engage the whole class in discussions
    e. Allow students to decide how best to communicate their work.
    f. Provide differentiated background readings according to student reading level
    g. Provide students with a choice of different assignments.

16. About how often do students in this class take part in the following types of science activities?

    Almost never

    A few times a year

    Once or twice a month

    Once or twice a week

    All or almost all lessons

    a. Answer textbook or worksheet questions

       Ask scientifically oriented questions (NOT ASKED)

    b. Critically examine the scientific explanations of other students
    c. Do hands-on/laboratory science activities or investigations
    d. Explain their findings and conclusions to other students
    e. Follow specific instructions in an activity or investigation
    f. Plan investigations to answer scientific questions
    g. Prepare written science reports
    h. Record, represent and/or analyze data
    i. Support their explanations with scientific knowledge
    j. Use data to support an explanation
    k. Work on extended science investigations or projects (a week or more in duration)

17. To what extent, if at all, are you currently implementing inquiry learning? Consider the level of implementation of the different features along with variations in amount of student self-direction.

    - not at all
    - A little bit (One or two features with little or no variations)
    - Somewhat (some features with some variations)
    - Moderately (Most or all features with some variations)
    - Very much so (All features with most or all of their variations)

18. Please indicate the title, author, publisher, and publication year of the **science** textbook/program used **most often** by students in this class.

19. Is this a kit-based program or a text-based program?

Section C: Teacher Opinions

20. Please rate your agreement with the following statements about science teaching in your school: (Strongly Disagree, Disagree, Agree, Strongly Agree)
    a. I enjoy teaching science.
    b. I consider myself a "master" science teacher.
    c. Administrators regularly observe classrooms to monitor implementation of inquiry learning
    d. Science teachers in this school regularly observe each other teaching classes in order to learn how to implement inquiry-based lessons.
    e. Teachers meet following ELI professional development sessions to discuss or plan implementation
    f. Teachers meet to examine student work (e.g. to study the effectiveness of inquiry lessons)
    g. Teachers receive in-school coaching and/or modeling to support inquiry-based instruction

21. To what extent does your principal, assistant principal, or department head?

    Not at all/Slightly

    Somewhat

    Moderately

    Very much so

    a. understand inquiry-based instruction
    b. communicate expectations about implementing inquiry learning
    c. encourage teacher collaboration to support inquiry learning (e.g., lesson planning, observing lessons, reviewing student work, etc.)
    d. monitor teacher implementation of inquiry learning.

22. Please rate your agreement with the following statements about your teaching resources for inquiry learning: (Strongly Disagree, Disagree, Agree, Strongly Agree)
    a. I have sufficient planning and preparation time to create inquiry-based lessons
    b. I have adequate lab space and lab equipment to support inquiry learning
    c. I have enough well-stocked science kits or boxes to support inquiry learning
    d. I have instructional materials that align with inquiry learning
    e. I have time during the regular school week to work with my colleagues on implementation of inquiry learning.

23. To what extent do you feel prepared to deliver science lessons that do the following?

Not at all/Slightly prepared

Somewhat prepared

Moderately prepared

Very prepared

a. Engage student interest in a concept or problem
b. Elicit responses to discover what students know or think about a concept
c. Provide common experiences for students to test their own ideas about a problem and compare them to others
d. Provide experiences that challenge the current conceptions of students
e. Introduce scientific terms or concepts that help students explain previous experiences
f. Provide opportunities for students to apply developing concepts to new situations

24. To what extent has your participation in Every Learner Inquires prepared you to do each of the following?

Not at all/Slightly

Somewhat

Moderately

Very much so

a. Implement inquiry-based science instruction
b. Teach inquiry-based lessons to groups that are heterogeneous in ability
c. Differentiate instruction while implementing inquiry-based lessons
d. Evaluate student work products from inquiry-based lessons
e. Align inquiry-based lessons to local science standards

25. Have you encountered any barriers to implementing inquiry-based science instruction this year? If so, please describe.

26. To what extent do you think your use of inquiry-based instruction has improved the following for your students?

Not at all/Slightly

Somewhat

Moderately

Very much so

a. Active engagement in science lessons

b. Understanding of scientific concepts

c. Enthusiasm in science

d. Understanding of the scientific inquiry process

Teacher Background

The following questions are for tracking purposes only. Identifying information will be stripped from your survey responses.

27. What is your name? __________________

28. What school do you teach at? (MANDATORY)

a. Harlan High School (Harlan CSD)

b. Lincoln Elementary School (Washington CSD)

c. Mechanicsville Elementary (North Cedar CSD)

d. Perkins Academy (Des Moines CSD)

e. Other (please specify)

Appendix D.
Student Science Classroom Survey

You are invited to take a brief survey about your science class this year. The purpose of this survey will be used to understand what students think about science. The survey will take about 10 to 15 minutes to finish. You do not have to do the survey if you do not want to. If you do not fill out your survey, it will not affect your grade. Do not sign your name on this survey.

Section 1: About You. Please fill out the following information:

Name of School:	**Your grade:** 3 4 5 6
Name of Science teacher:	☐ Male ☐ Female

Section 2: Your Science Class
Instructions: You will read a several statements about your science class. For each statement, decide if it is true for you. If it is true, mark **Yes**. If it is not true, mark **No**. If it is sometimes true, mark **Sometimes**. Remember, all of these statements are about your science class, not any other class of yours.

In my science class…

1. I discuss ideas in science class. ☐ Yes ☐ No ☐ Sometimes
2. I give my opinions during class discussions. ☐ Yes ☐ No ☐ Sometimes
3. The teacher asks me questions. ☐ Yes ☐ No ☐ Sometimes
4. My ideas and suggestions are used during classroom discussions. ☐ Yes ☐ No ☐ Sometimes
5. I ask the teacher questions. ☐ Yes ☐ No ☐ Sometimes
6. I explain my ideas to other students. ☐ Yes ☐ No ☐ Sometimes
7. I talk with other students about how to solve problems. ☐ Yes ☐ No ☐ Sometimes
8. I am asked to explain how I solve problems. ☐ Yes ☐ No ☐ Sometimes

In my science class…

1. I carry out investigations to test my ideas. ☐ Yes ☐ No ☐ Sometimes
2. I am asked to think about the evidence for statements. ☐ Yes ☐ No ☐ Sometimes
3. I carry out investigations to answer questions coming from discussions. ☐ Yes ☐ No ☐ Sometimes
4. I explain the meaning of statements, diagrams and graphs. ☐ Yes ☐ No ☐ Sometimes
5. I carry out investigations to answer questions which puzzle me. ☐ Yes ☐ No ☐ Sometimes
6. I carry out investigations to answer the teacher's questions. ☐ Yes ☐ No ☐ Sometimes
7. I find out answers to questions by doing investigations. ☐ Yes ☐ No ☐ Sometimes

8. I solve problems by using information from my own investigations.	☐ Yes	☐ No	☐ Sometimes

Section 3: Your Opinions about Science Class.

You will read several statements about how you feel about science class. Please mark Yes, No, or Sometimes to say whether each statement is true for you.

1. I consider myself a good science student.	☐ Yes	☐ No	☐ Sometimes
2. I would probably do well in science in high school or college.	☐ Yes	☐ No	☐ Sometimes
3. Most students can do well in science if they try.	☐ Yes	☐ No	☐ Sometimes
4. If my teacher asked me to collect data to answer a question, I would know how to do it.	☐ Yes	☐ No	☐ Sometimes
5. Science lessons are fun.	☐ Yes	☐ No	☐ Sometimes
6. School should have more science lessons each week	☐ Yes	☐ No	☐ Sometimes
7. Science is one of the most interesting subjects in school.	☐ Yes	☐ No	☐ Sometimes
8. I really enjoy going to science lessons.	☐ Yes	☐ No	☐ Sometimes
9. I look forward to science lessons.	☐ Yes	☐ No	☐ Sometimes
10. Everyone should learn about science.	☐ Yes	☐ No	☐ Sometimes

Appendix E. ELI Instructional Tracking Form

Instructions: Please fill out one form for each science lesson (a lesson may extend over several class periods). Place a checkmark to indicate each variation of each essential feature of inquiry your science lesson included. Your responses are confidential.

1. **Teacher name:** ________________________________
2. **School:** ______________________________________
3. **Grade:** ___________
4. **Lesson Date:** _________________
5. **Duration of Lesson (hours and minutes):**____________________________
6. **Name of Unit:** ____

Essential Feature	Variations			
Learner engages in scientifically oriented questions.	Learner poses a question.	Learner selects among questions, poses new questions.	Learner sharpens or clarifies a question provided by the teacher, materials, or other source.	Learner engages in a question provided by the teacher, materials, or other source.
Learner gives priority to evidence in responding to questions.	Learner determines what constitutes evidence and collects it.	Learner is directed to collect certain data.	Learner is given data and asked to analyze.	Learner is given data and told how to analyze.
Learner formulates explanations from evidence.	Learner formulates explanations after summarizing evidence.	Learner is guided in process of formulating explanations from evidence.	Learner is given possible ways to use evidence to formulate explanation.	Learner is provided with evidence.
Learner connects explanations to scientific knowledge.	Learner independently examines other resources and forms the links to explanations.	Learner is directed toward areas and sources of scientific knowledge.	Learner is given possible connections.	
Learner communicates and justifies explanations.	Learner forms reasonable and logical argument to communicate explanation.	Learner is coached in development of communication.	Learner is provided broad guidelines to use to sharpen communication.	Learner is given steps and procedures for communication.

Appendix F.
Interview Protocols

Teacher Interview Protocol

Teacher Background

1. How many years have you been teaching?

2. How many years have you been at this school?

3. What sort of science certification do you hold?

4. Did your college background prepare you to teach the science content in your course?

Post-Observation Follow Up

We have just a few questions to follow-up on the lesson we observed.

5. What was the purpose of the lesson we observed?

6. [*Clarify any activities that were unclear.*]

7. In what ways do you think that the design of future instruction will take into account what happened in this lesson?

A. Teacher Learning and Practice

8. To what extent do you understand the essential features of inquiry-based science instruction? *Probe: which aspects do you understand the most or least?*

9. To what extent have you been implementing inquiry-based science instruction over the past three months? *Probe: Please describe which essential feature of inquiry has been reflected in your daily lessons.*

10. Have you encountered any barriers to implementing inquiry-based science in your classroom? (PROBE: what are these barriers?)

10A. Have you been attempting to differentiate instruction when doing inquiry learning? (*Probe: what are the barriers to doing so?)*

11. How well do you understand the 5E learning cycle? *Probe: Which aspects do you understand the best?*

12. To what extent have you been using the 5E learning cycle over the past three months? *Probe: Which parts of the cycle have you been using?*

13. What barriers, if any, have you encountered in using the 5E learning cycle?

14. How does students' behavior impact your implementation of inquiry-based instruction?

14A. On what topics in inquiry-based instruction do you feel you need additional training?

B. Professional Development

15. To what extent and in what respects has the Every Learner Inquires professional development lived up to your expectations?

16. Have you attended all of the workshops offered through the Every Learner Inquires Program? *Probe: Which ones have you missed?*

16A. Have you received additional professional development from ELI staff outside of the workshops?

17. What are the major ways, if any, that the Every Learner Inquires professional development has impacted your instruction?

17A. How well did the Every Learner Inquires professional development prepare you to implement inquiry learning? PROBE: *Did you have a clear understanding about how you should be implementing what you learned in each workshop?*

18. What are the strengths of the professional development offered through Every Learner Inquires?

19. How could the professional development be improved to help you implement inquiry-based instruction?

C. Organizational Support

Now I'd like to ask you a few questions about your school and how it is supporting the ELI program.

19A. To begin with, are there any external factors that are influencing ELI, such as major changes in the school or district or other initiatives? PROBE: In what way do these affect implementation of ELI?

20. Does your principal or any other administrator communicate expectations about your implementation of inquiry-based instruction? (*PROBE: If so, what are these expectations?*)

21. Who in your school monitors the implementation of inquiry-based instruction? How does monitoring occur?

22. Describe opportunities to plan and collaborate with other teachers on inquiry-based science instruction? *Probe: when and how often?*

23. Are you provided with an adequate amount of time to plan Inquiry-based lessons?

24. What curriculum materials do you use for science instruction?

25. To what extent do these curriculum materials support inquiry-based science instruction?

26. To what extent have you needed to modify your curriculum materials so they would be in alignment with the inquiry approach?

D. Student Learning

27. How has your implementation of inquiry-based science instruction affected the way your students learn science?

28. To what extent are your students able to engage in the process of scientific inquiry? *Probe: In what way(s) is this apparent?*

29. Does the program address the needs of all students? *Probe: To what extent does the instructional approach of Every Learner Inquires meet the needs of special education students or English Language Learners?*

30. Have all students in your class had the opportunity to complete a full inquiry cycle?

31. Have you noticed any changes in student attitudes towards learning science? *Probe: Are they more enthusiastic or confident about science?*

32. Has your implementation of inquiry-based science instruction affected the level of student engagement? *Probe: How can you tell?*

E. Closing Remarks

33. Is there anything else that I should know regarding the Every Learner Inquiry program?

Principal Interview Protocol

Section A. Teacher Practice

1. To what extent have teachers at this school been implementing inquiry-based science instruction over the past three months? *PROBE: Please describe which essential feature of inquiry have been reflected in daily lessons of teachers*

2. Have your teachers encountered any barriers to implementing inquiry-based science in your classroom? (PROBE: What are these barriers?)

3. To what extent have teachers in this school been using the 5E learning cycle over the past three months? *Probe: Which parts of the cycle have they been using?*

Section B. Professional Development

4. To what extent and in what respects has the Every Learner Inquires professional development lived up to your expectations?

5. Have you attended all of the workshops offered through Every Learner Inquires? *Probe: Which one(s) did you miss?*

6A. Have your teachers received additional professional development from ELI staff outside of the workshops?

6. How well did the Every Learner Inquires professional development prepare your teachers to implement inquiry learning?

7A. What sort of guidance do your teachers receive about how to apply what they have learned in the ELI workshops? *PROBE: Do your teachers have a clear understanding about how they should be implementing what they learned in each workshop?*

7. How have the Every Learner Inquires workshops affected science instruction at your school?

8. What are the strengths of the professional development (i.e. workshops and trainings) offered through Every Learner Inquires?

9. How could the professional development offered through Every Learner Inquires be improved?

10. What topics do your teachers need additional training on?

Section C. Organizational Support

Now I'd like to ask you a few questions about your school and how it is supporting the ELI program.

11A. To begin with, are there any external factors that are influencing ELI, such as major changes in the school or district or other initiatives? PROBE: In what way do these affect implementation of ELI?

11. What is your role in supporting your teachers in implementing inquiry-based instruction?

12. What are your expectations about classroom implementation of inquiry-based science instruction? (PROBE: How do you communicate these expectations?)

13. To what extent do you monitor the implementation of Inquiry learning? How is this done?

14. Are their regular opportunities during the day for teachers to collaborate and plan for inquiry-based science instruction? Please describe.

15. To what extent do the science curriculum materials at your school support inquiry-based science instruction?

Section D. Student Learning

16. How has the school's implementation of inquiry-based science instruction affected the way the students learn science?

17. Does the program address the needs of all students (such as special education students and English Language Learners)?

18. Have you noticed any changes in student attitudes towards learning science? *Probe: Are students more enthusiastic or confident about science?*

19. Has the implementation of inquiry-based science instruction affected the level of student engagement? *Probe: How can you tell?*

Section E. Closing Remarks

20. Is there anything else that I should know regarding the Every Learner Inquiry initiative at your school?

That is the end of the interview. Thank you for your time

Every Learner Inquires Classroom Observation Protocol

Teacher:	______________________	**Date:**	__________	**Grade**:	______
School:	______________________	**Course:**	______________________		
Observer:	____________________	**Start Time:**	________	**End Time:**	______

I. Demographics

A.. Number of Students

1. Number of boys____________ 2. Number of girls____________

B. Rate the adequacy of the physical environment.

1. Classroom resources:

☐	☐	☐	☐	☐
1	2	3	4	5
Sparsely equipped				Rich in resources

2. Classroom Space:

☐	☐	☐	☐	☐
1	2	3	4	5
Crowded				Adequate space

3. Room arrangement:

☐	☐	☐	☐	☐
1	2	3	4	5
Inhibited interactions among students				Facilitated interactions among students

II. Purpose of Lesson

Indicate the *primary intended purpose(s)* of this lesson or activity based on the pre- and/or post-observation interviews with the teacher and lesson plans.

☐ 1. Identifying prior student knowledge
☐ 2. Introducing new concepts
☐ 3. Developing conceptual understanding
☐ 4. Reviewing science concepts
☐ 5. Developing problem-solving skills
☐ 6. Learning science processes, algorithms, or procedures
☐ 7. Introducing scientific terms, vocabulary or specific facts
☐ 8. Practicing scientific computations for mastery
☐ 9. Developing appreciation for core ideas in science
☐ 10. Assessing student understanding

III. Classroom Instruction

A. Indicate the *major5 way(s)* in which student activities were structured.

☐ As a whole group ☐ As small groups ☐ As pairs ☐ As individuals

B. Indicate the *major5 way(s)* in which students engaged in class activities.

☐ Entire class was engaged in the same activities at the same time.
☐ Groups of students were engaged in different activities at the same time (e.g., centers).

C. Indicate the *major activities* of students in this lesson. When choosing an "umbrella" category, be sure to indicate subcategories that apply as well. (For example, if you mark "listened to a presentation," indicate by whom.)

☐ 1. Listened to a presentation:
  ☐ a. By teacher (would include: demonstrations, lectures, media presentations, extensive procedural instructions)
  ☐ b. By student (would include informal, as well as formal, presentations of their work)
  ☐ c. By guest speaker/"expert" serving as a resource
☐ 2. Engaged in discussion/seminar:
  ☐ a. Whole group
  ☐ b. Small groups/pairs
☐ 3. Engaged in reading/reflection/written communication about mathematics or science:
  ☐ a. Read about mathematics/science
  ☐ b. Answered textbook/worksheet questions
  ☐ c. Reflected on readings, activities, or problems individually or in groups
  ☐ d. Prepared a written report
  ☐ e. Wrote a description of a plan, procedure, or problem-solving process
  ☐ f. Wrote reflections in a notebook or journal
☐ 4. Engaged in problem solving/investigation:
  ☐ a. Worked with manipulatives
  ☐ b. Played a game to build or review knowledge/skills
  ☐ c. Followed specific instructions in an investigation
  ☐ d. Had some latitude in designing an investigation
  ☐ e. Recorded, represented and/or analyzed data
  ☐ f. Recognized patterns, cycles or trends ☐ g. Evaluated the validity of arguments or claims
  ☐ h. Provided an informal justification or formal proof
☐ 5. Other activities
  ☐ a. Arts and crafts activity
  ☐ b. Listened to a story
  ☐ c. Wrote a poem or story
  ☐ d. Other (Please specify.) ____

D. Science Investigation. Place a checkmark to indicate each variation of each essential feature your science lesson included. If the variation is not described, add a brief description in the *Other* column.

Essential Feature	Variations			
Learner engages in scientifically oriented questions.	Learner poses a question.	Learner selects among questions, poses new questions.	Learner sharpens or clarifies a question provided by the teacher, materials, or other source.	Learner engages in a question provided by the teacher, materials, or other source.
Learner gives priority to evidence in responding to questions.	Learner determines what constitutes evidence and collects it.	Learner is directed to collect certain data.	Learner is given data and asked to analyze.	Learner is given data and told how to analyze.
Learner formulates explanations from evidence.	Learner formulates explanations after summarizing evidence.	Learner is guided in process of formulating explanations from evidence.	Learner is given possible ways to use evidence to formulate explanation.	Learner is provided with evidence.
Learner connects explanations to scientific knowledge.	Learner independently examines other resources and forms the links to explanations.	Learner is directed toward areas and sources of scientific knowledge.	Learner is given possible connections.	
Learner communicates and justifies explanations.	Learner forms reasonable and logical argument to communicate explanation.	Learner is coached in development of communication.	Learner is provided broad guidelines to use to sharpen communication.	Learner is given steps and procedures for communication.

E. Comments

Please provide any additional information you consider necessary to capture the activities or context of this lesson.

IV. Design	Did not occur	Somewhat descriptive	Very descriptive
1. In this lesson, student exploration preceded formal presentation.	☐	☐	☐
2. The lesson included activities designed to pique students' curiosity and generate interest.	☐	☐	☐
3. The resources available in this lesson contributed to accomplishing the purposes of the instruction.	☐	☐	☐
4. The design of the lesson encouraged a collaborative approach to learning.	☐	☐	☐
5. Adequate time and structure were provided for "wrap up" (i.e., reviewing what was learned and how).	☐	☐	☐

6. Teacher provided time for students to compare their ideas with those of others and perhaps to revise their thinking	☐	☐	☐
7. Adequate time and structure were provided for students to make sense of their experiences.	☐	☐	☐
V. Instruction	Did not occur	Somewhat descriptive	Very descriptive
1. Teacher invited students to raise their own questions	☐	☐	☐
2. Teacher asked probing questions to help students make sense of their experiences	☐	☐	☐
3. Teacher introduced terminology and alternative explanations after students express their ideas	☐	☐	☐
4. Teacher requested justification (evidence) for students' explanations	☐	☐	☐
5. Teacher asked questions that helped students express understanding and explanations.	☐	☐	☐
6. The lesson was modified as needed based on teacher questioning or other student assessments.	☐	☐	☐
7. The focus and direction of the lesson was often determined by ideas originating with students.	☐	☐	☐
8. Teacher encouraged students to use what they have learned to explain a new event or idea	☐	☐	☐
VI. Content	Did not occur	Somewhat descriptive	Very descriptive
9. The science content was significant and worthwhile.	☐	☐	☐
10. Appropriate connections were made to other areas of science, to other disciplines, and/or to real-world contexts.	☐	☐	☐
11. Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	☐	☐	☐
VII. Climate	Did not occur	Somewhat descriptive	Very descriptive
12. Active participation of all was encouraged and valued.	☐	☐	☐
13. Interactions reflected collegial working relationships among students (e.g., students worked together, talked with each other about the lesson).	☐	☐	☐
14. The teacher acted as a resource person, working to support and enhance student investigations.	☐	☐	☐
15. There was a climate of respect for students' ideas, questions, and contributions.	☐	☐	☐
16. The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions.	☐	☐	☐

Time	Description of Events

Time	Description of Events

Every Learner Inquires Classroom Observation Protocol

Teacher:	______________	**Date:**	______	**Grade**:	______
School:	______________	**Course:**	______________		
Observer:	______________	**Start Time:**	______	**End Time:**	______

I. Demographics

A.. Number of Students

1. Number of boys____________ 2. Number of girls____________

B. Rate the adequacy of the physical environment.

1. Classroom resources:

☐	☐	☐	☐	☐
1	2	3	4	5
Sparsely equipped				Rich in resources

2. Classroom Space:

☐	☐	☐	☐	☐
1	2	3	4	5
Crowded				Adequate space

3. Room arrangement:

☐	☐	☐	☐	☐
1	2	3	4	5
Inhibited interactions among students				Facilitated interactions among students

II. Purpose of Lesson

Indicate the *primary intended purpose(s)* of this lesson or activity based on the pre- and/or post-observation interviews with the teacher and lesson plans.

☐ 1. Identifying prior student knowledge
☐ 2. Introducing new concepts
☐ 3. Developing conceptual understanding
☐ 4. Reviewing science concepts
☐ 5. Developing problem-solving skills
☐ 6. Learning science processes, algorithms, or procedures
☐ 7. Introducing scientific terms, vocabulary or specific facts
☐ 8. Practicing scientific computations for mastery
☐ 9. Developing appreciation for core ideas in science
☐ 10. Assessing student understanding

III. Classroom Instruction

A. Indicate the *major5 way(s)* in which student activities were structured.

☐ As a whole group ☐ As small groups ☐ As pairs ☐ As individuals

B. Indicate the *major5 way(s)* in which students engaged in class activities.

☐ Entire class was engaged in the same activities at the same time.
☐ Groups of students were engaged in different activities at the same time (e.g., centers).

C. Indicate the *major activities* of students in this lesson. When choosing an "umbrella" category, be sure to indicate subcategories that apply as well. (For example, if you mark "listened to a presentation," indicate by whom.)

☐ 1. Listened to a presentation:
- ☐ a. By teacher (would include: demonstrations, lectures, media presentations, extensive procedural instructions)
- ☐ b. By student (would include informal, as well as formal, presentations of their work)
- ☐ c. By guest speaker/"expert" serving as a resource

☐ 2. Engaged in discussion/seminar:
- ☐ a. Whole group
- ☐ b. Small groups/pairs

☐ 3. Engaged in reading/reflection/written communication about mathematics or science:
- ☐ a. Read about mathematics/science
- ☐ b. Answered textbook/worksheet questions
- ☐ c. Reflected on readings, activities, or problems individually or in groups
- ☐ d. Prepared a written report
- ☐ e. Wrote a description of a plan, procedure, or problem-solving process
- ☐ f. Wrote reflections in a notebook or journal

☐ 4. Engaged in problem solving/investigation:
- ☐ a. Worked with manipulatives
- ☐ b. Played a game to build or review knowledge/skills
- ☐ c. Followed specific instructions in an investigation
- ☐ d. Had some latitude in designing an investigation
- ☐ e. Recorded, represented and/or analyzed data
- ☐ f. Recognized patterns, cycles or trends ☐ g. Evaluated the validity of arguments or claims
- ☐ h. Provided an informal justification or formal proof

☐ 5. Other activities
- ☐ a. Arts and crafts activity
- ☐ b. Listened to a story
- ☐ c. Wrote a poem or story
- ☐ d. Other (Please specify.) ______________________________

D. Science Investigation. Place a checkmark to indicate each variation of each essential feature your science lesson included. If the variation is not described, add a brief description in the *Other* column.

Essential Feature	Variations			
Learner engages in scientifically oriented questions.	Learner poses a question.	Learner selects among questions, poses new questions.	Learner sharpens or clarifies a question provided by the teacher, materials, or other source.	Learner engages in a question provided by the teacher, materials, or other source.
Learner gives priority to evidence in responding to questions.	Learner determines what constitutes evidence and collects it.	Learner is directed to collect certain data.	Learner is given data and asked to analyze.	Learner is given data and told how to analyze.
Learner formulates explanations from evidence.	Learner formulates explanations after summarizing evidence.	Learner is guided in process of formulating explanations from evidence.	Learner is given possible ways to use evidence to formulate explanation.	Learner is provided with evidence.
Learner connects explanations to scientific knowledge.	Learner independently examines other resources and forms the links to explanations.	Learner is directed toward areas and sources of scientific knowledge.	Learner is given possible connections.	
Learner communicates and justifies explanations.	Learner forms reasonable and logical argument to communicate explanation.	Learner is coached in development of communication.	Learner is provided broad guidelines to use to sharpen communication.	Learner is given steps and procedures for communication.

E. Comments

Please provide any additional information you consider necessary to capture the activities or context of this lesson.

IV. Design	Did not occur	Somewhat descriptive	Very descriptive
1. In this lesson, student exploration preceded formal presentation.	☐	☐	☐
2. The lesson included activities designed to pique students' curiosity and generate interest.	☐	☐	☐
3. The resources available in this lesson contributed to accomplishing the purposes of the instruction.	☐	☐	☐
4. The design of the lesson encouraged a collaborative approach to learning.	☐	☐	☐
5. Adequate time and structure were provided for "wrap up" (i.e., reviewing what was learned and how).	☐	☐	☐

6. Teacher provided time for students to compare their ideas with those of others and perhaps to revise their thinking	☐	☐	☐
7. Adequate time and structure were provided for students to make sense of their experiences.	☐	☐	☐
V. Instruction	Did not occur	Somewhat descriptive	Very descriptive
1. Teacher invited students to raise their own questions	☐	☐	☐
2. Teacher asked probing questions to help students make sense of their experiences	☐	☐	☐
3. Teacher introduced terminology and alternative explanations after students express their ideas	☐	☐	☐
4. Teacher requested justification (evidence) for students' explanations	☐	☐	☐
5. Teacher asked questions that helped students express understanding and explanations.	☐	☐	☐
6. The lesson was modified as needed based on teacher questioning or other student assessments.	☐	☐	☐
7. The focus and direction of the lesson was often determined by ideas originating with students.	☐	☐	☐
8. Teacher encouraged students to use what they have learned to explain a new event or idea	☐	☐	☐
VI. Content	Did not occur	Somewhat descriptive	Very descriptive
9. The science content was significant and worthwhile.	☐	☐	☐
10. Appropriate connections were made to other areas of science, to other disciplines, and/or to real-world contexts.	☐	☐	☐
11. Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	☐	☐	☐
VII. Climate	Did not occur	Somewhat descriptive	Very descriptive
12. Active participation of all was encouraged and valued.	☐	☐	☐
13. Interactions reflected collegial working relationships among students (e.g., students worked together, talked with each other about the lesson).	☐	☐	☐
14. The teacher acted as a resource person, working to support and enhance student investigations.	☐	☐	☐
15. There was a climate of respect for students' ideas, questions, and contributions.	☐	☐	☐
16. The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions.	☐	☐	☐

Time	Description of Events

Time	Description of Events

Appendix H.
Frequency of Essential Features and Their Variations

Essential Feature	**Variations**			
	Level 4	**Level 3**	**Level 2**	**Level 1**
Learner engages in scientifically-oriented questions	Learner poses a question	Learner selects among questions, poses new questions	Learner sharpens or clarifies a question provided by the teacher, materials, or other source	Learner engages in a question provided by the teacher, materials, or other source
Observed Frequency	**2**	**0**	**0**	**6**
Learner gives priority to evidence in responding to questions	Learner determines what constitutes evidence and collects it	Learner is directed to collect certain data	Learner is given data and asked to analyze	Learner is given data and told how to analyze
Observed Frequency	**2**	**2**	**0**	**1**
Learner formulates explanations from evidence	Learner formulates explanations after summarizing evidence	Learner is guided in process of formulating explanations from evidence	Learner is given possible ways to use evidence to formulate explanation	Learner is provided with evidence
Observed Frequency	**1**	**0**	**0**	**1**
Learner connects explanations to scientific knowledge	Learner independently examines other resources and forms the links to explanations	Learner is directed toward areas and sources of scientific knowledge	Learner is given possible connections	
Observed Frequency	**0**	**0**	**2**	**0**
Learner communicates and justifies explanations	Learner forms reasonable and logical argument to communicate explanation	Learner is coached in development of communication	Learner is provided broad guidelines to use to sharpen communication	Learner is given steps and procedures for communication
Observed Frequency	**0**	**1**	**0**	**0**

Appendix I.
Correlation Matrix for Teacher Survey Scales

		Implementation	Professional Learning	Principal Support	Resources
Implementation	Pearson Correlation	1	.371(**)	.141	.370(**)
	Sig. (2-tailed)		.007	.320	.007
	N	52	52	52	52
Professional Learning	Pearson Correlation	.371(**)	1	.671(**)	.309(*)
	Sig. (2-tailed)	.007		.000	.023
	N	52	54	54	54
Principal Support	Pearson Correlation	.141	.671(**)	1	.272(*)
	Sig. (2-tailed)	.320	.000		.047
	N	52	54	54	54
Resources	Pearson Correlation	.370(**)	.309(*)	.272(*)	1
	Sig. (2-tailed)	.007	.023	.047	
	N	52	54	54	54

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).